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ROADS and STREETS

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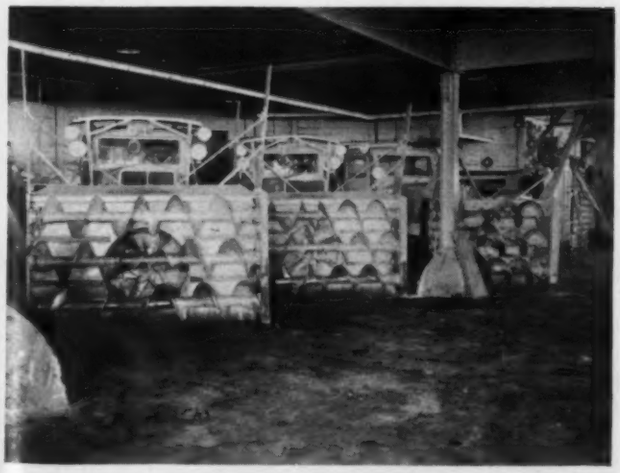
COMMUNICATION IMPORTANT SNOW CONTROL FACTOR

High Mountain Roads and Passes On Main Routes Kept Open

"BETTER go by the south route this time of year." How often have you heard that admonition when discussing a trip by automobile over the Rocky Mountains during the winter months? You've heard it many times. It is a hangover expression from the days of early motor vehicle travel. Crossing the high Sierras or Cascades on regularly traveled through routes is less hazardous, so far as getting snowbound or stuck in the snow is concerned, than is travel across the great plains or prairie states during a storm. Efficient snow control organizations are ready at a moment's notice to guarantee an open road. Take for instance, Donner's Pass on U. S. 40 between Reno, Nev., and Sacramento, Calif., or the crossing from Redding, Calif., to Alturas.

Many difficulties that were insurmountable 15 years ago have been overcome to such a degree today that they are just another part of the regular maintenance routine of snow control. Today, one of the most difficult problems faced by highway maintenance forces in their annual routine of keeping an open road in the high snow country is the lack of adequate communication with the man and equipment on the fighting front. Often, with the first hard storm, wires go down in many sections, and are not repaired until spring. In other locations, communication facilities either do not exist or are inadequate so far as snow removal maintenance work is concerned. Naturally, messenger service is impossible, hence there is a real need for two-way radio communication. The State of Washington has had fine results from the radio communication established there. Without it, communication channels are functionally inadequate when needed most.

Just Over the Summit on Donner's Pass, About 7,000 Ft. Elevation, Showing How Snow Fighters Keep U. S. 40 Clear. This View Is on the Eastern Slope.



Rotary Snogos Resting Between Storms in the Donner's Summit Maintenance Station on U. S. 40 Between Reno, Nevada, and Sacramento, Calif.

A serious aspect of the inadequacy or failure of communication is the lack of knowledge at entrances to storm areas as to what roads have become blocked. Lines of cars are held needlessly long at control gates, or worse, are released too soon. When snow is drifting, conditions may so change in 30 minutes that motor vehicles are trapped, unable to move either way. Fortunately, however, the modern efficient snow removal equipment can release them rapidly if the point of stoppage is known. This led California to follow Washington's example and equip at least one highway district with two way radio communication for test during the 1938-39 winter.

Highway District No. II has approximately 25 per

At Big Bend Ranger Station, About 6,000 Ft. Elevation, on the Western Slope on the Way Up to Donners Pass, U. S. 40. Road Cleared Without Traffic Delay in Last Storm.

cent of the snow removal mileage, and maintains the north and northeastern gateways to the state. Radio equipment was installed at the district office in Redding, Calif., at each superintendent's headquarters, and on all rotary snow plows.

Snow fighting equipment at Donner's Pass on U. S. 40 was not so equipped. The snow fall was lighter this

Mobile Radio Unit on Rotary Plow Standing in Front of Fixed Station at Mt. Shasta Maintenance Yard. Note the Triangular Arrangement of Aerials of Fixed Station and Operating Position of Mobile Unit Antenna.

year than for many years. It will be recalled that Donner's Pass was named after that pioneer group led by Donner who wintered along the shores of the beautiful lake, now bearing his name, on the eastern side of the mountains. Quarreling, which led to differences of opinion and leadership, as well as lack of food made stark tragedy the camp companion of this embattled party. What took many months for the remnants of that pioneer party to accomplish, namely, the crossing of the pass in winter, is now accomplished in less than an hour. Control barriers or gates are operated during storms and pilot cars conduct motor travel over the 7,000 ft. peak whenever there is a least bit of doubt as to the ease of individual travel.

Rotary, V, and side push snow plows clear the road as needed. At the summit is a highway department maintenance garage where the equipment is serviced

Interior of Redding District Office Radio Control Room on U. S. 99 in California. C. I. Brown Operating Redding Station KASN

and kept ready. Tall 8-ft. stakes are attached to guide posts that mark the boundaries of the road. These stakes guide the snow fighters in darkness as well as daylight. When a storm is blowing, all equipment works night and day. Powerful headlights and spotlights provide the necessary illumination for night work. In very heavy storms, traffic may be held up at the control stations for several hours, but usually not more than a

Mobile Unit with Both Sending and Receiving Antennae in Operating Position. This Unit Is Based on the Mt. Shasta Station.

couple of hours is lost. Before a car is permitted through the gates, during a storm, or even immediately after, it must put on a good set of skid chains.

Radio Tests

In August, 1938, a test car was equipped with radio to obtain data on which to base an estimate of the kind of equipment and power required to provide reliable communication between the plows and their base, and between Redding and the maintenance stations. Not only are distances in this area great but the rough terrain hides sections of highways in deep canyons making radio reception difficult. One can readily understand this phenomena, who has tried to get radio programs in his car while driving in mountainous country.

The transmitter sets specified after tests were completed are designed to work on either standard house current of 110 volts and 60 cycles, or on a 12-volt truck battery. They are either 50-watt telephone type or telegraph type sets or a combination of both. The change-over from house current for energy to the truck battery is almost instantaneous, requiring only the changing of the plug from one socket to another. These transmitters are duplicates, in size and in controls of the snow plow sets.

Transmitters on the plows operate as telephone type only. The telegraph type at District and base stations are necessary because frequently static so interferes or dead spots so occur as to obliterate voice reception. Following is a table of the present set up of equipment:

RADIO STATIONS—DIST. II

Location	Call Letters	Station No.	Power Telegraph, Watts	Power Telephone, Watts
Fixed Stations				
Redding	KASN	2	300	200
Yreka	KATT	20	300	200
Mt. Shasta City	KATR	21	50	50
Burney	KATX	22	50	50
Alturas	KATW	23	50	50
Mineral	KATU	24	50	50
Susanville	KATS	25	50	50
Quincy	KATQ	26	50	50
Pulga	KATV	27	50	50
Mobile Stations				
Snow plow—Yreka	KASN	2Y	...	50
Snogo, Weed	KASN	2W	...	50
Snogo, Mt. Shasta	KASN	2S	...	50
Snogo, Burney	KASN	2B	...	50
Snow plow, Alturas	KASN	2A	...	50
Snogo, Mineral	KASN	2M	...	50
Snogo, Goodrich	KASN	2G	...	50
Snogo, Lost Creek	KASN	2L	...	50
Test car, CHC-7037	KASO	28	...	15

Interior of Snogo Rotary Cab Showing Installation of Transmitting and Receiving Radio Equipment

Snogo Opening Yuba Pass, Sierra County.

As can be noted in the table, transmitters on plows have only 50 watts power, which is sufficient. Power is supplied by the truck battery, high voltages being developed by a genemotor. So efficient is the design of these transmitters that the drain on the battery, while transmitting, is less than the maximum charging rate of the generator on the plow. They are mounted on rubber washers to minimize shocks and are practically waterproof.

Plow Cab Speakers

Receivers are the fixed frequency type, permanently tuned to the assigned frequencies.

Voice—2726 kilocycles
Telegraph—3190 kilocycles

The speakers in the snow plow cabs are mounted on the wall of the cab in order to make the receiver as

Front View of Opening Work on Yuba Pass.

Traffic Waiting in Line for Uphill Passage Over Icy Pavement on North Side of Tejon Pass on U. S. 99, North of Los Angeles in Los Angeles County, Calif.

small and compact as possible. The fixed station receivers have integral speakers. Merely by turning a panel knob, the station receivers can be changed from 110 volt a.c. to 12-volt d.c. power. The rotary plows, of course, are designed for 12-volt operation only.

Antennae Problem.—Because of interferences, long distances, and dead spots, one of the difficulties encountered in the design of these stations was to plan effective antennae. For five of the fixed stations, three 100-ft. poles of red fir erected in the form of a triangle, carry the antennae. At three others advantage was taken of standing trees. The fixed station transmitting antennae is a half wave length (171 ft. 6 in.), the receiving antennae being of the doublet type, 140 ft. long with a coil in the middle.

Plow antennae presented a more difficult problem. An entirely new type was developed after experiments and tests of all types heretofore used or available. When not in use the antenna folds back over the cab and body

Traffic Waiting in Double Line for Downhill Passage Over Icy Pavement on North Side of Tejon Pass, North Los Angeles, Calif., on U. S. 99. Such Concentration of Traffic Prevented Operation of Plows and Sanding Equipment.

of the plow. In this position it extends only to the back bumper and is raised about 12 in. above the cab. When it is desired to transmit, the operator raises the antenna by means of a lever in the cab, so that it stands 12 ft. vertically, then he turns a small crank which telescopes the antenna to a height of 23 ft. It is rugged in construction (was built in the Sacramento shops of the highway department) and has proved highly efficient.

Operation

The test period permitted by the Federal Communications Commission elapsed in February and the time this was written, the highway department was waiting for approval of their application to operate and to extend the system. To provide operators, examinations were held at various points in the district. Many of the wives of men employed studied for the examination.

Operating procedure has been simplified by the use of printed forms upon which the daily road and weather report is compiled. In about 15 minutes each morning before the men go to work, a "round-robin" rapid fire

Showing How Proper Location of Snow Fence Cut Drifting on Road U. S. 395, Mono County, Calif., South of McGee Creek.

exchange of information is accomplished. After this is over each station in the system knows the condition of all roads in the district, the weather and temperature at point, and the forecast for the next 24 hours.

Throughout the day the plows report hourly. A constant standby is maintained at all stations, and by all plows on duty, so that district headquarters has an hour by hour picture of progress on the fighting snow-front. Breakdowns or calls for assistance are reported immediately, which guarantees a minimum loss of time in clearing roads. Only during storms is there a day and night watch.

All Year Travel

This kind of maintenance service, when extended to all districts in the snow belts of the Rockies insure all-year travel between the East and the West. The writer would have no hesitation whatever in starting from Chicago for Sacramento or Redding at any time during the winter but would, of course, stay on the Federal numbered main roads. The old admonition to travel the south route to California is not so necessary now, thanks to our efficiently organized snow control maintenance crews.

Rotary Snogo Widening Strawberry Slide, San Bernardino County, Calif.

RELATIONSHIP OF AERIAL MAPPING TO HIGHWAY ENGINEERING

By J. C. CARPENTER
Senior Highway Engineer,
U. S. Bureau of Public Roads

THE sum total of the use of aerial maps by highway engineers is an infinitesimal quantity, but this quantity is increasing rather than diminishing. One reason for the small use of aerial mapping and the apparent indifference of the highway engineering profession is that there are very few aerial maps available. The situation may be likened to the homely expression that "If we had some ham we could have some ham and eggs, if we had some eggs." When good maps are available, highway engineers will be eager to use them.

Highway location practice has followed closely the procedure used on railway location. The nature of the problem; that is, the development of an engineering location over an area having extreme length as compared to its width, did not lend itself to solution through the development of aerial maps. In contrast, consider the development of a flood control or reclamation district such as the Brazos River Conservation and Reclamation District in Texas. In these areas, more nearly circular in shape, aerial mapping can be carried on economically and it is readily apparent to everyone that this method of mapping is ideally suited to the solution of the problem. Modern planning of highways contemplates the study of an area of appreciable width, which means that aerial mapping can and will be used advantageously.

It is a common understanding that the only time a map is needed by a highway engineer is when he makes a location survey, but this applies only to the inadequate maps now available. Accurate, scientifically prepared maps will be used for location, construction, maintenance, planning, valuation and many other purposes.

Aerial Maps in Planning Highway Systems

Complete and accurate aerial maps may be used for planning of systems of highways. The important highway systems of the country such as the Federal Aid system, state highway systems and the secondary systems that are now under consideration can be planned with real scientific methods when aerial maps are available. The State-wide Highway Planning Surveys have collected and tabulated information that is exceedingly valuable for this purpose. Aerial maps will supplement this data and allow its analysis and the application of planning methods with confidence that the results will be satisfactory. Beyond these three systems, which occupy about 17 per cent of the total mileage, is a vast area of local service roads that must be planned, built and maintained, and it is self-evident that good maps will be needed for this work.

Detailed location of individual routes in any system of highways will be materially aided by good topographic maps. The actual location of these routes is ordinarily left to an instrument man who develops the alignment that topography appears to dictate. With complete maps this development can be projected by more experienced engineers and checked in the control office by experts who have had long experience in highway location. It is conceded by some highway engineers, who have given careful study to the subject, that route maps can be prepared from good aerial maps supplemented by the aerial photographs of the area under consideration. Reliable maps allow the comparison of routes as to their relative alignment, grades, cost of construction, value to agriculture and industry and other features. With ownership maps covering the routes under consideration it is entirely possible to negotiate for right-of-way without arousing the countryside by numerous surveys on the ground.

Value of Accurate Topographic Maps

Plans for construction can not be prepared from aerial maps without a field survey, but these maps provide excellent supplemental data for use in the design which ordinarily can not be obtained without surveys of such extent that the cost is considered prohibitive. An example of such utilization is that of the design of drainage structures. On accurate topographic maps the area of a watershed, its shape, the slopes of the land, character of vegetation and land use can be determined. Development of this information for a number of drainage areas will allow the intelligent evaluation of our present practice of determining required areas of drainage openings and the revision of these practices to insure economy in construction and safety for the structures. The actual location of the structure on the stream can be carefully selected and much better analysis of all locations can be made by study of detailed topographic maps than by individual surveys of each site. Another use of good maps is in the study of the availability of local materials for surfacing, for concrete for structures and the development of economy in haul of these materials. Accurate contour maps will no doubt point out sources of good material that may not be evident without them.

Construction operations on a project can be planned with greater economy when accurate maps are available. Contractors' engineers will arrange their operations so as to save construction costs and these economies will be reflected in the costs that are eventually passed on to the paying public. The engineer in charge for the owner will also be able to more intelligently supervise the construction if he has complete, accurate maps of the area to supplement the construction plans.

After the construction has been completed, maintenance operations can be more satisfactorily carried on if good maps are available. There are many ways the maps may be used, but it is obvious that the construction uses enumerated above, such as for checking drainage areas, location of materials, planning of operations, etc., are applicable alike to maintenance procedure. Geological investigations of surface conditions, stimulated by the existence of comprehensive maps, will un-

doubtedly bring to light many good materials for highway use that have been overlooked in the past.

Suggestions for Logical Plan for Mapping

It is appropriate, at this time, that some program of mapping, using the highways as an important element, be described. The following suggestions are offered as a logical plan for mapping of the country.

There are three distinct procedures involved in modern mapping: 1. Ground control. 2. Flying and photography. 3. Projection of planimetric data, development of the contours and printing of the finished maps.

The main highways of the country offer an ideal location for the development of accurate geodetic control both horizontally and vertically. For complete control the spacing of lines should average about six miles, but for present purposes and as a matter of correct priority, a spacing along the main highways approximately thirty-six miles apart will serve. The primary arcs of triangulation have been projected across the country and it will be a comparatively simple matter to tie in the main highways. For this purpose it is recommended that control points be set at a maximum distance of two miles along all the main highways and that these points be intervisible. Plane coordinates and elevations for these points should be determined, adjusted and marked on the monuments. These main highways serve the larger concentrations of population and pass through the most valuable lands of the country. Accurate control thus established will therefore be of maximum value to the public located along the main highways. This location will also serve in the application of geodetic control to land boundaries and for all other kindred purposes. With such a rigid network thus established, all highway planning operations can be coordinated and locations inter-related in a manner that is not now possible. The value of a uniform basic control for all highway locations, all adjacent engineering operations, all land boundary control and other supplemental developments can not be estimated but it is, needless to say, very great.

After the control is established flights and photography should be planned to center on these controls. These operations may be carried on so as to provide for final development of a series of quadrangles fitting into the system projected by the U. S. Geological Survey. Some careful planning will be required to accomplish this end and still make the mapping economical and most useful. It is unquestionably reasonable, though, that maps prepared using a control lying along the main highways will have the maximum of accuracy at the locations where there is the maximum concentration of value and population. The scale of the completed maps, dependent upon detail required for the area being mapped, will determine the specification to be used in flying and photographing.

Scales Based on Duodecimal System Best Suited

The development of the completed topographic maps will be accomplished by projection with some method in current use. Scales used are important and before any extensive program is started there should be a determination of policy on this phase of mapping. Highway engineers use the conventional triangular scale with inches subdivided in tenths and multiples thereof. Consequently the use of scales based on the duodecimal system is best suited to the work of highway engineers. The most common scale in use for highway plans is 1 in. = 100 ft. or 1:1,200. It thus follows that scales best suited to our work are 1:1,200; 1:2,400; 1:6,000; 1:12,000; 1:24,000 and 1:48,000. For contour intervals 1 ft., 2 ft., 5 ft., 10 ft., 20 ft. and 40 ft. might well be adopted. The scales commonly used for topographic maps are suitable for large area mapping, but for highway planning, location, construction and maintenance we need maps on familiar scales if we are to win over practicing highway engineers to their use It would seem to me that our mapping should be so planned as to provide finished sheets on a scale of 1:12,000 (1 in. = 1,000 ft.) and contour interval of 10 ft. If larger areas are to be covered the scale can be reduced by doubling to 1:24,000 and again to 1:48,000. The work should be performed with accuracy that will allow enlargement to 1:6,000, but it is quite probable that remapping will be required for the 1:2,400 and 1:1,200 scales and smaller contour intervals.

Aerial mapping is destined to become one of the most valuable aids to the highway engineer. The stimulus required to inoculate the profession in the development of a sufficient number of usable maps to allow the field engineers and administrative officials to realize the potential value in their use. Conversely, highway engineers can do a great service to the public by developing the projection of geodetic control along the main highways, photographing the areas centered thereon and completion of the topographic maps as suggested. This procedure appeals to me as the one best suited to bring the value of mapping to the attention of the largest number of people in the shortest time. With this grid of control and mapping completed, adjusted and in use, there will be no doubt of the completion of the intervening areas. When we have completed the mapping along the main highways we will have the "ham" and there will be no difficulty in getting the "eggs" to make our "ham and eggs."

▼

Road System of Wayne County, Michigan.—The County Road Commissioners of Wayne County, Michigan, have 2,342 miles of roads under their jurisdiction. This may be divided into three classes, namely, paved roads, which are considered primary roads; unpaved township roads, or secondary roads, which serve as feeders to the primary system; and the subdivision streets and alleys which may be considered strictly local roads, serving the people living on them but which are also feeders to either primary or secondary roads. The mileages of these are as follows:

	Miles
Primary Roads	493
Secondary Roads	665
Local Streets	808
Alleys	376
Total	2,342

There are over 200 miles of state trunk line and Federal Aid roads in the county, not included in the county system, which are under the direct supervision of the State Highway Department. The responsibility for providing service on these roads rests with the State Highway Department. An agreement has been executed with the State Highway Department whereby the Board of Road Commissioners maintain all traffic signals at trunk line intersections.

▼

Chicago Superhighway Bill Now a Law.—The third and final measure of the state legislature authorizing the construction of a $60,000,000 superhighway system for Chicago became a law on July 26.

SNOW REMOVAL THAT IS SNOW REMOVAL

A SNOW period of 6 months, a season's snowfall that has reached 226 in., and 700 miles of road to be kept open, make winter maintenance in Houghton County, Michigan, a difficult and expensive job. The county is located on the Keweenaw peninsula in the extreme northern part of Michigan. Being located in Lake Superior, winds from the east, north and west sweep the snow into high drifts.

Farm to Market Road, 1939

The county road mileage consists of approximtaely 900 miles, of which 100 miles are streets in unincorporated villages and mining locations. In addition to this mileage, the County Road Commission has been continuously engaged by the Michigan State Highway Department to maintain about 100 miles of state trunk line roads within the county. During the past winter a total of approximately 700 miles of roads were kept open for wheel traffic, while the balance of the mileage was maintained for sleigh traffic.

Road Opened After a Severe Storm

The country's snow fighting equipment consists of fourteen 5 and 10-ton truck plows, five auger type rotaries and three tractor type rotaries. In addition the county has 250,000 ft. of snow fence.

The snowfall in Houghton County for the past winter which started in November, 1938, measured 226½ in. This is an all time record. All recordings were made by an authorized branch of United States Weather Bureau located at Calumet, where snow measurements were first started in the year of 1888. As a comparison to this all-time record, the following is a tabulation of snowfall in Houghton County for the past six winters:

Street in One of the Unincorporated Villages, High Snow Drifts Screen the Houses.

	Inches
Winter of 1933 and 1934.....	124.75
Winter of 1934 and 1935.....	146.50
Winter of 1935 and 1936.....	191.00
Winter of 1936 and 1937.....	127.25
Winter of 1938 and 1939.....	226.50

All work in Houghton County is supervised by Mr. Carl F. Winkler, the county highway engineer.

In addition to its regular snow removal work, the Commission performs many other services. They are called upon daily for some urgent personal service, such as the plowing of roads for doctors and assisting them to

Rotary Widening Highway on State Trunk Line M 2o

reach their patients in rural areas; escorting school busses along their routes during blizzards; providing wheel service for funerals, standing by to enable fire departments to make their call when alarms are sounded, and numerous other similar requests.

Rural Road Opened for Traffic

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ In driving steel sheet piling for a cofferdam the contractor on the Pennsylvania Avenue Bridge, Washington, D. C., encountered the problem of driving under the high tension wires of the Pennsylvania Railroad. To solve his problem and insure safety to man and machine he designed the long follower shown here. The wires passed through the opening in the follower. There were no accidents.

• •

¶ Out in Montana they claim that: Silver Bow County is an exceptionally rich county; so rich, in fact, that every blade of grass has a green back, every bird has a bill, the chimneys have their drafts and the maids wash our front steps with Gold Dust; every horse has a check and every ditch has two banks; even our streets are flushed and the lawns get a rake off; every cloud has a silver lining and every flower in the county has a cent; when you put a five dollar bill in your pocket you double it, and when you take it out you find it in creases.

• •

¶ Setting a Sign.

Select a shady, weedy, or advertising sign cluttered spot about 100 ft. from a curve or intersection, well down on the shoulder of the road or back of a guard rail for protection. Be sure to jab the ground with a pick or crowbar and select the softest spot, because, after all, it would not do to dull the sharp edges of the digging tools. Dig until your back gets tired unless the end of the post can be pushed down at least a foot. After the post is set be careful not to bump it from a vertical position, then bolt signboard on post.

For convenience of those who may want a reflector button or two, hang a wrench on the sign. To assist riflemen, concentric circles painted around the reflector button is suggested.

Next deftly apply white paint to the post. Consult your maintenance manual for the leg length of dogs in the neighborhood and carefully paint lower end of post, black.

• •

¶ From the Montana Center Line:
DON'T USE BIG WORDS

In promulating your esoteric cogitations and in articulating your superficial sentimentalities and amicable philosophical or psychological observations, beware of platitudinous ponderosity. Let your conversational communications possess a clarified consciseness, a compacted comprehensibleness, coalescent consistency, and a concatenated cogency. Eschew all conglomerations of flatulent garrulity, jejune babblement, asinine affectations. Let your extemporaneous descantings and unpremeditated expatiations have intelligibility and veracious vivacity without rhodomontade or thrasonical bombast. Sedulously avoid all polysyllabic profundity, pompous prolixity, psittacious vacuity, ventriloquial verbosity, and vaniloquent vapidity. Shun double ententes, prurient jocosity, and pestiferous profanity, obscurant or apparent. In other words, talk plainly, briefly, naturally, sensibly, purely, and truthfully. Keep from slang, do not put on airs, say what you mean, mean what you say, and DON'T USE BIG WORDS.

• •

¶ We read somewhere that engineers are often baffled by the fact that some of the girls with streamlined figures offer the most resistance.

• •

¶ Test load on a timber bearing pile of pier 6 of the Pennsylvania Ave. bridge over the Anacostia River, Washington, D. C. The total load was 50 tons; settlement, 11/16 inch; recovery, 100 per cent. The water tank rests on railroad iron which are balanced on the pile head. Slack guys prevent toppling by wind pressure.

HIGHWAYS OF HISTORY

1814—COASTWISE TRAVEL

¶ The infant highway system was overtaxed during the War of 1812 when the British blockade bottled coastwise sailing packets in the harbors. The freight business between New England and the South was transferred to the Conestoga wagons which with carts and coaches rumbled over the Delaware River bridge at Trenton, New Jersey.

1826—MICHIGAN ROAD

¶ Meanwhile the French Canadian, Pierre Frieschutz Navarre, with his fur-trading cabin on the east bank of the Saint Joseph River was laying unknowingly the foundation for the future city of South Bend. Over the Michigan Road connecting the Ohio River with Lake Michigan settlers poured into Indiana to take up homesteads.

1836—EL CAMINO REAL

¶ While the struggle for survival of the best kinds of transportation was raging east of the Mississippi River, settlers were pushing southwestward. Past the Alamo, stormed shortly before by Mexican troops led by General Santa Ana, covered wagons, carretta carts, and pack animals moved slowly along El Camino Real.

1822—SANTA FE TRAIL

¶ The Santa Fe Trail from the western frontier of the United States at Independence, Missouri, was the first of the overland roads to the Far West. At the starting point near the Missouri River the traders tightened their steel wagon tires.

1830—MAYSVILLE TURNPIKE

¶ The Maysville Pike through the Blue Grass Region of Kentucky recalls the failure to win Federal aid for a southwest branch of the National Road from Zanesville, Ohio, to New Orleans. President Andrew Jackson vetoed the bill.

1840—CUMBERLAND ROAD

¶ Begun in 1806 to serve territory N.W. of Ohio River, the National Pike was first main road built by Federal funds. By 1840, near its eastern end, wagons and stage coaches began to lose business to B. & O. Ry.

1825—ERIE CANAL

¶ In the East, canals challenged the supremacy of the horseways. The Erie Canal, completed in 1825, provided an almost level water route across the Appalachian Mountain barrier to the Great Lakes. New York, thus joined with the new States carved from the Northwest Territory, now displaced Philadelphia.

1830—COOPER'S LOCOMOTIVE

¶ But now a new contender rose to challenge the highway and waterway for the right to serve the growing nation's transportation. On the Baltimore and Ohio Railroad, Peter Cooper's Tom Thumb locomotive, because of a breakdown, lost the race with a horsedrawn car, but none-theless proved railway superiority.

1843—OREGON TRAIL

¶ The trickle of trappers to the Northwest when Astoria was founded in 1811 had swelled to a mighty stream of settlers with the Great Emigration of 1843. The Oregon Trail over the Rocky Mountains and down the Columbia River formed, with the extended National Pike, an overland connection from coast to coast.

In reply to a government questionnaire, 23,095 business concerns said they used trucks because they gave them faster service than railroads.

American Road

WASHINGTON, D. C.

WORKS ADMINISTRATOR CARMODY

"Roads are not used too much, they're used too little. There's not enough of them. They're not good enough—not safe enough! They don't keep pace with automotive output!"

These sentiments are of particular interest to every Road Builder, since they were expressed by John Michael Carmody, first administrator of the newly created Federal Works Agency, which houses the Public Roads Administration. Administrator Carmody voiced his views and his plans in an exclusive interview with Robert E. Harper, director of public relations for the American Road Builders' Association.

"I know that tourism is fast becoming one of this country's top-flight industries," he declared. "It is already number one in several states. I am glad that this condition exists. People live only once and I see no reason why all of them, youngsters and oldsters alike, should not become better acquainted with the 'greener pastures' beyond the horizons of their own surroundings. Our 48 states abound with points of natural beauty and historic interest. Good roads, properly maintained, make these scenic attractions accessible to all our citizens.

"I believe that safe highways can be provided for the comfortable, convenient and safe use of the ever-increasing legions of highway users by applying the principle of modern engineering. I'm for obtaining rights-of-

(*Continued on next page*)

Down the Road

by CHARLES M. UPHAM

Engineer-Director,
American Road Builders' Association, Washington, D. C.

RAILROADS TURN TO HIGHWAYS FOR PROFIT

The driving of the golden spike at Promontory Point, Utah, in 1869, symbolized the final linking of America's railroad-transportation service from coast to coast. Citizens on hand for the celebration of that historic occasion had little reason to doubt that they could now travel by rail to any place in the country where business obligations or recreational desires might in future draw them. They would have scoffed at the suggestion that, in less than a hundred years the boundaries set by the cross-country railroad lines would prove far too restricted for the broadened horizons of their grandchildren.

The rapid growth of the highway-transportation industry has in recent years far outstripped railroad facilities. In the twentieth-century rediscovery of America, people are finding outstanding attractions in spots that cannot be reached by train. Highways are proving their only link to many scenic and historic localities, as well as to many recreational opportunities. The travelling salesman is finding a growing number of his best buyers in communities lacking convenient rail connections. The he-man vacationist is discovering his trout-filled mountain streams far from any railroad station. Scenery from a train window is usually far less stimulating than that found adjacent to the roadside.

Each year the railroads are finding more and more of their best customers lured away by the increased convenience and unlimited scenic-interest area provided by motor-vehicle transportation. It has been clearly brought home to them that they must act to combat the handicap placed on their services by the fact that the train can only travel within its designated right-of-way. How will they do this? With automobiles and the use of the highways, of course! No wonder, then, that they are enthusiastically backing the idea of a Nebraska automobile dealer that may prove at least a partial solution to their problem.

Ed O'Shea of Lincoln has devised a plan to suit the traveller who has no taste for a long motor trip. He may leave his own car at home, board a railroad train for the major part of his journey and yet enjoy automobile facilities wherever he finds them useful during the long and otherwise boresome trip. With this end in view, the Railroad Extension Service has been organized. Beginning January 1, 1940, railroad passengers will be offered an automobile leasing service. The O'Shea company will operate from the Great Lakes to the Pacific Coast and from Texas to Canada in nearly 400 cities, chiefly centers of more than 10,000 population.

Railroads that have already been lined up for the proposed service include Burlington, Chicago & Northwestern, Chicago & Eastern Illinois, Illinois Central, Missouri, Kansas & Texas; Missouri Pacific, Union Pacific and Chicago, St. Paul, Minneapolis & Omaha. Automobile corporations are naturally highly in favor of the plan, since it calls for approximately 15,000 new low-priced cars.

Under the program being set up, the traveller will purchase a railroad ticket in the usual fashion. But, at each point along the line which he designates, a uniformed attendant will meet the train and place a car at his disposal.

Tomorrow's tourists will, through the use of good and safe highways, be enabled to go where they want to go, do what they want to do, see what they want to see. No beauty spot or historically famous section will be so remote that they cannot ride in comfort and convenience to its door. The American highway system again proves itself a diminisher of distances and a magic carpet for the ever-increasing army of American tourists who continue to seek greener pastures.

Builders' Review

AUGUST, 1939

More than one-fourth of all the research laboratories in the United States are maintained by the motor-vehicle industry and its suppliers.

SAYS "ROADS NOT GOOD ENOUGH"

1940 ROAD SHOW-CONVENTION TO BE STAGED IN CHICAGO

"Roads to Recovery" will theme note the 1940 Road Show and Convention of the American Road Builders' Association in Chicago's International Amphitheater, January 29-February 2. Decision on the time and place for the coming conclave was reached at a recent meeting of the association's Joint Exhibit Committee. Advance predictions, based on the interest already being shown by Road Builders throughout the country, are that the 1940 meet will break all previous records for attendance and number of materials and machinery exhibits.

The last Chicago Road Show-Convention of the ARBA took place thirteen years ago and many Road Builders have recommended a return to the Windy City. This fact, as well as Chicago's central location, should help make this meeting the largest and most successful in the association's 37-year history. Pre-convention activity is already under way. Application blanks are being issued. Initial mailing pieces and other promotional literature are in the mails. Stickers, blotters and envelope stuffers to promote the event are being designed.

Chicago's Stevens hotel has been designated as ARBA headquarters during the conclave. The Illinois Road Builders' Association, Illinois state ARBA affiliate, will have headquarters at the Blackstone hotel and act as host to Road Show-Convention delegates.

CARMODY SAYS

(Continued from preceding page)

way on a much larger scale. I'm for extensive roadside development and highway beautification. I'm for space annihilation with safety on our highways. The main reason why people use planes is to save time in travel. Highways must eventually provide the same facility."

Before assuming his new post, Mr. Carmody was for two years administrator of the Rural Electrification Administration. In this job, he pointed out, "the chief deterrent to the progress of our schedule to string so many miles of line a day was the lack of passable roads in rural areas. We must not lose sight of that fact that, in addition to the improvement of our major highways, we still have the problem on our hands of lifting rural America out of the mud."

Emphasizing the value of roads as an unemployment cure, he declared, "The construction of new highways will put thousands of our unemployed back to work on the most worth while of public projects. The employment of these workers will create additional demands for labor and will provide the incentive for outside agencies to invest additional funds. New highway construction will put more men to work, in more places, faster and with greater returns for the worker and taxpayer for each dollar spent than any other public enterprise.

"As to the new endeavor that lies just ahead, it is not my plan to set up at the top one iota of duplication of the work that is already being carried on by the various Federal Works Administration agencies. It is rather my desire to work through and with all existing agencies and to strive to retain within them all activities that are at present giving satisfaction and that are being handled efficiently. With respect to roads, we shall endeavor to maintain the same high standards that made the Bureau of Public Roads such a successful arm of the federal government. I have been impressed by the splendid research and laboratory work that is being carried on by the Bureau personnel under the efficient direction of Thomas H. McDonald. This will, of course, be continued. We shall continue to search for better materials and methods with a restless determination and the results of our research will be put to public use to the best possible advantage within our allotted appropriations.

"So far as industry is concerned, we shall make every effort to acquaint all phases of industry depending on road building for a livelihood with our plans as far in advance as can be determined."

ARBA AIDS IN RESTRICTING WPA EQUIPMENT PURCHASES

Co-operative efforts of the American Road Builders' Association and its state affiliates aided in the recent passage of an amendment restricting WPA purchases of road-bulding equipment and machinery. James B. Kenney, secretary of the Colorado Association of Highway Contractors, an ARBA affiliate, testified before committees of the United States Senate and House of Representatives in support of the measure. In response to an ARBA quesionnaire, manufacturer members wired and telephoned their disapproval of WPA's equipment purchases. This support of the measure by large manufacturers and distributors greatly influenced the appropriations committee. The amendment, which is a part of the $1,755,600,000 federal appropriations bill, prohibits WPA from expending relief appropriations for the purchase or acquisition of construction equipment which duplicates facilities already owned or available for construction work through the channels of private enterprise.

HIGHWAY HOLIDAY PROPOSAL DEFEATED IN N. DAKOTA

North Dakota citizens last month defeated a proposal for a two-year state highway holiday by a vote of five to one. Passage of the measure would have meant the diversion of motor-vehicle revenues to old-age pensions and other non-highway purposes. No new highway construction could have been started in the state for a two-year period and maintenance work would have been severely restricted. The ARBA co-operated with North Dakota organizations in bringing about the defeat of the measure. Wire stories, news releases and radio material were sent from the association's Washington offices to North Dakota newspapers and other interested publications and persons. An ARBA canvass of congressional opinion, conducted before the July 11 balloting, revealed that North Dakota Senators Lynn J. Frazier and Gerald P. Nye and Congressman William Lemke were strongly opposed to the road-building holiday proposal.

RURAL MAIL ROUTES AND ROAD PROBLEMS

By JAMES S. BURCH
Engineer of Statistics and Planning, North Carolina State Highway and Public Works Commission

RURAL letter carriers and the personnel of the North Carolina State Highway and Public Works Commission have much in common. First of all, of course, all are public servants, and as such all attempt in every way to provide the most extensive and efficient service possible under the existing limitations. Further, all of us have a direct interest in the welfare of the rural citizens of the State. The Commission realizes that one of the most important ways in which it can serve the rural public is by keeping the mail routes in such condition throughout the year that the travel will be economical, safe, and comfortable. Uppermost in the minds of rural letter carriers, no doubt, is the desire for more extensive improvement of the county roads in order that they may render more efficient service in the handling of communications and the deliveries of merchandise.

The Commission and its personnel are just as anxious as the letter carriers to improve the service of these local roads. However, the Commission is faced with definite limitations as to what it can do because of the enormous mileage involved, because of the urgent needs of the state highway system, and because of the relatively low annual income per mile to the highway fund. In order to comprehend the magnitude of the highway commission's problem, Mr. Burch suggested his talk before the North Carolina Rural Letter Carriers' Association on July 3 that they look for a few moments at the size of its component parts and compare North Carolina's situation with that prevailing in some of the other states.

Mileage

The Commission operates two state-wide road systems: first, the State Highway System, which comprises the U. S. and N. C. numbered routes; and second, the County Road System, which includes generally the remainder of the rural roads. The length of the state highway system is more than 11,000 miles, and if continuous, it would reach from North Carolina to Shanghai, China—all in North Carolina. If the county road system of more than 48,000 miles is added, the total length would reach more than twice around the world.

All this mileage is the sole responsibility of the state highway commission for maintenance and improvement for year-round travel. Today it carries more than a half-million motor vehicles, which travel about four billion vehicle miles each year. Furthermore, the commission is caring for this entire mileage without the benefit of any property tax, road tax, bridge tolls, or any other income except the tax on the motor vehicle license plates, and on gasoline. No other state in the Union has attempted such a task, although North Carolina has been operating in this way for the past eight years.

Road-Use Toll

In this system of road financing, no person pays for roads except in proportion to his use of the roads. As a matter of fact, the gasoline tax, which is in effect a road-use toll, is not actually a tax at all; in view of the fact that the savings in vehicle operating costs, because of improved roads, is much more than the road tax per mile. The toll for road-use by the average vehicle is about ½c per mile. That is the approximate amount which the state highway commission gets from the use of each mile of road by each motor vehicles which uses it.

Now, it has always been known that a motor vehicle would operate cheaper on an improved road than on one not improved. In order to evaluate this saving, about a year ago an arrangement was made in another state for 293 rural mail carriers to keep exact costs of operation throughout a full year, these costs to be related to the type of road on which they were traveling. These 293 cars traveled more than 3 million miles, and after the data on costs were carefully analyzed, it was found that the average cost of operation adjusted to annual travel volume was 6.22c per mile on dirt roads, 5.62c per mile on gravel, sand-clay, and topsoils; and 4.63c on pavement. These costs, of course, included the use of the car, gasoline, oil, tires, and all other vehicle expenses.

Benefits

From these data it is seen that the improvement of a dirt road to gravel or topsoil road saves 0.6c per vehicle mile for the average car, and that the change from gravel or sand-clay to pavement results in saving 1c per vehicle mile in vehicle operating costs. Since the North Carolina road tax is only ½c per mile, it is obvious that those who travel on improved roads save considerably more than the road toll which they pay out. Therefore, from the users' standpoint, good roads are provided at no real cost to anyone. Of course, there must be enough use of a given road to defray its annual cost, or else the road will not warrant improvement.

Limits

And there is the basic answer to the question as to "Why are not these benefits extended to the entire rural road system." Let us remember that on the county road system the average traffic is about 40 vehicles per day. That is on the average county road, some of which carry several hundred vehicles per day, but the majority of which carry from 10 to 25 vehicles per day. Now if a road carries 40 vehicles per day, the average propor-

tionate income to the highway fund from a mile of that road is only about $70.00 in a whole year. You realize how little can be done in road improvements on that amount of income. However, the commission's annual income is by no means available in full for current operations. For the last eight years, because of expenditures to cover bonded indebtedness and debt service, due to transfers to the general fund, the maintenance of the Motor Vehicle Bureau and the Highway Patrol, the maintenance of the Parole and Probation Commission and otherwise, less than 60 per cent of the motor vehicle revenue has been available for current expenditures.

However, if we admit that the whole $70.00 per mile gross earnings by the average county road is available for county road improvement, let's see what has been expended on county roads. Starting with fiscal 1935, the average expenditure per mile on the county road system has been—not $70.00, but: 1935, $139.00; 1936, $198.00; 1937, $222.00; 1938, $258.00.

These annual expenditures include certain Federal-Aid Allocations, but one can see that the commission is putting back into these county roads many times the amount of their gross earnings.

These figures are presented to show that most of the county roads earn hardly enough to justify their upkeep to more than a minimum standard of efficiency. The highway commission operates on a self-paying and self-sustaining enterprise. There is no magic whereby it can ignore its financial limitations and extend its operations beyond the limits of its income. [Too bad it's not the Federal Government.—Ed.] These county road expenditures, which are higher than the income from these roads, are made possible because of the great earning power of the main state highway system. The commission feels that these expenditures are wise, because the county roads act as feeders to the state highways, and because the commission is anxious to extend improved road service to the greatest possible number of the rural citizens.

From this discussion it may be seen that, although the highway organization is anxious to do all that it can in improving the county roads, there is simply a definite economic limit beyond which expenditure is neither justified nor possible.

State Highway System

The local county roads would be of very little value were it not for that great backbone of our transportation network; namely, the state highway system. North Carolina was one of the pioneer states in envisioning and executing a broad scale state highway system. This has been one of the prides of the state, but unfortunately, due to age and fiscal stringency, North Carolina is no longer in the top rank with respect to its state highway system. Obsolescence and depreciation have taken their toll, and the system is badly in need of modernization from the standpoint of safety, economical operation, comfort, and salvage. About 10 per cent of the high type, high cost pavements are more than fifteen years old, and 69 per cent are more than ten years old. Preliminary studies indicate an average life of 13 to 20 years of these pavements. Thus we know that a large mileage of these expensive pavements will have to be rebuilt within the next few years. There is no highway surplus, or reserve which can be called upon to finance such replacements.

Obsolescence

Taking the "all weather" roads on the state highway system into consideration, we find that 21 per cent of them are no more than 16 feet wide (and trucks are 8 feet wide). On the entire state highway system there are 1,304 narrow bridges, i.e., no wider than 18 feet, and the aggregate length of these bridges is 29 miles. These bridges are a menace to traffic, but bridge widening is very expensive, and again there is no surplus or reserve available for this work. We have thousands of sharp curves on the state highway system. Taking only those sections which carry more than 1,000 vehicles a day, we find an excessively sharp curve every 2¼ miles on the average, and we find a blind spot every half mile on the average. We are faced with the immediate need for overhauling and modernizing this system.

Precaution

The highway commission has been able to do a satisfactory job during the past eight or ten years on limited funds only due to two favorable facts. First, the high type pavements were relatively new and required little special maintenance or replacement. Second, the Federal Government has made generous allocations and contributions for roads in North Carolina, the average annual amount being more than 5½ million dollars. Future considerations must involve extreme precaution because, first, the present condition of these high type pavements indicates a highway mortality rate, requiring broad scale replacements in the next few years, and second, it is extremely doubtful that the Federal Government may be depended upon to continue the allocation of more than minimum amounts in the future for highway construction and reconstruction. It will be recalled that, as an economy measure, the President in December of 1937 urged Congress to completely discontinue highway federal aid.

Sometimes the state engineers are asked about the logic of expenditures for such work as landscape work along highways and the expenditure for the Blue Ridge Parkway. Perhaps one may be interested in knowing certain facts about these special activities.

Landscape Work.—The landscape work is designed primarily to cut down the shoulder maintenance cost through the elimination of erosion, and to make the shoulders and road slopes safer, and thus avoid accidents. A minor feature is the aesthetic appearance of the resulting improvement. Incidentally, half the funds used on landscape projects are federal aid funds earmarked exclusively for this purpose. There is no doubt that a landscaped road is safer, cheaper to maintain, and more pleasing to travel.

Parkway.—On the Blue Ridge Parkway, the only funds expended by the state are for furnishing right-of-way and making location surveys. The National Park Service is paying for this super-scenic highway in the clouds. The commission feels that the Blue Ridge Parkway is good business for North Carolina. Already the annual income from out-of-state motor vehicle traffic is more than double the annual value of the lint cotton crop. It is estimated that tourists spend more than 65 million dollars annually in this state. The National Park Service expects 2 million visitors the first year the Parkway is opened. If the Blue Ridge Parkway will materially increase the number of these tourists, then the expenditure for it by the state may easily be justified as a cold business venture. Already more people visit the Great Smoky Mountains National Park than the famous Yellowstone Park.

Aside from that, the Parkway will represent an excellent playground and vacation spot for the population of North Carolina, and will give the state one of the outstanding scenic parks in the United States.

Other Problems

Aside from strictly rural road problems, the commission is constantly importunated by towns and cities for increased financial aid in the maintenance and improvements of streets. Already a half million is allocated as such aid. The care of some 10,000 prisoners is a continuing burden on the highway fund because of the fact that these hand workers may not be economically employed throughout the year, due partly to the fact that such enoromous man power is not really needed for work that can best be done by machines, and partly because convict labor is not as efficient or productive as normal labor. Additional responsibilities are placed on the commission to keep all school bus routes in year-round travelable condition. The state is transporting to its consolidated schools daily more children than are transported by any other state in the nation. The task of keeping these school bus routes open and travelable throughout the winter is virtually an unprecedented attempt.

North Carolina is smaller in size than the average state, and has only about 24 per cent more population than the average state, but it maintains a primary state highway system about 53 per cent longer than the average of other states. And North Carolina is the only state which maintains all its rural roads without a levy of property tax for road purposes. There is no doubt in my mind that North Carolina is doing as good a road job, dollar for dollar and mile for mile, as any other state in the Union.

Local Road Jurisdiction

It is recalled that, prior to 1931, all county rural road matters in North Carolina had been subject to local administration by the Boards of County Commissioners. North Carolina was the first state in which the administration of all local roads was centralized in the State Government. This was considered in 1931 to be an experiment, and there were many who were skeptical as to the results of the plan. After eight years of experience, it is safe to say that the experiment has been successful. No appreciable dissatisfaction exists with the form of administration, or the manner in which road matters are being handled. There has never been a bill introduced in the legislature to return the control of county roads to the counties; and there is no evidence of a leader, or group, who advocates such a measure. The prevalent opinion is that the existing method results in the highest form of efficiency and economy in the operation, administration, and management of road matters in the state, and relieves property from tax burdens levied for road purposes. There is, however, adequate cause to proceed into the future with much precaution, because of the serious problems mentioned above.

Special Appropriations

It is felt that the present state administration under Governor Clyde R. Hoey has been most liberal with respect to funds for local county roads. In addition to funds allocated by the General Assembly, the Governor has authorized special expenditures in the amount of 9 million dollars during the last biennium. More than 65 per cent of this 9 million dollars of additional appropriations has been earmarked for the maintenance and betterment of the county roads.

Planing Survey

In order that the expenditure of road monies might be based more definitely on the relative needs in the various localities, there has been conducted during the past two years a broad state-wide highway planning survey. Among other things, the location of every rural house, church, school, store, has been mapped and data have been taken on the location and condition of every mile of road in the state. Traffic counts have been made on every road, and data are available to show the average traffic volume by types on every mile of road in the state. These facts are definitely considered in connection with any proposal for the addition of a new road to the system, or the improvement of an old road.

Commissioners

The state is divided into ten divisions and one member of the state highway commission lives in each division. Each of these men is fully appreciative of the problems and needs of the rural citizens, and he is constantly informed of their wishes. He and the engineers, and the entire personnel of the organization, attempt in every way to provide the best possible local road service, keeping in mind the number of people, and the needs of the particular community. While every one connected with the commission realizes the limitations imposed by the relative stringency of available funds, each and every one of them will give thorough, careful, and sympathetic consideration to any logical and reasonable proposal which may be made to him.

The employees of the highway commission are proud of the fine tradition and heritage which has been developed since the organization 18 years ago. There has never been so much as an insinuation of corruption, graft, or mismanagement throughout the long service of organization.

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EUROPEAN MOTOR FUEL TAXATION—Taxes on motor fuels in Europe ranged from 11 ct. to 53 ct. per U. S. gallon in 1938, according to Highway Research Abstracts. The following table gives a list of retail motor fuel prices per gallon in various cities, and the total tax levied, including duty:

MOTOR FUEL PRICES
(Cents Per U. S. Gallon)

Country and City	1938 Retail Price Autumn	Summer	Spring	Tax and Duty
Italy, Rome	81	81	72	53
Germany, Berlin	60	60	50	36
Bulgaria, Sofia	43	39	39	39
Czechoslovakia, Prague	42	42	42	16
Palestine, Jerusalem	38	40	39	22
Yugoslavia, Belgrade	39	40	41	26
Switzerland, Zurich	36	36	38	19
Hungary, Budapest	35	35	33	26
Latvia, Riga	36	38	38	15
Greece, Athens	32	33	34	20
United Kingdom, London	31	37	36	15
France, Paris	27	28	31	18
Norway, Oslo	27	28	27	11

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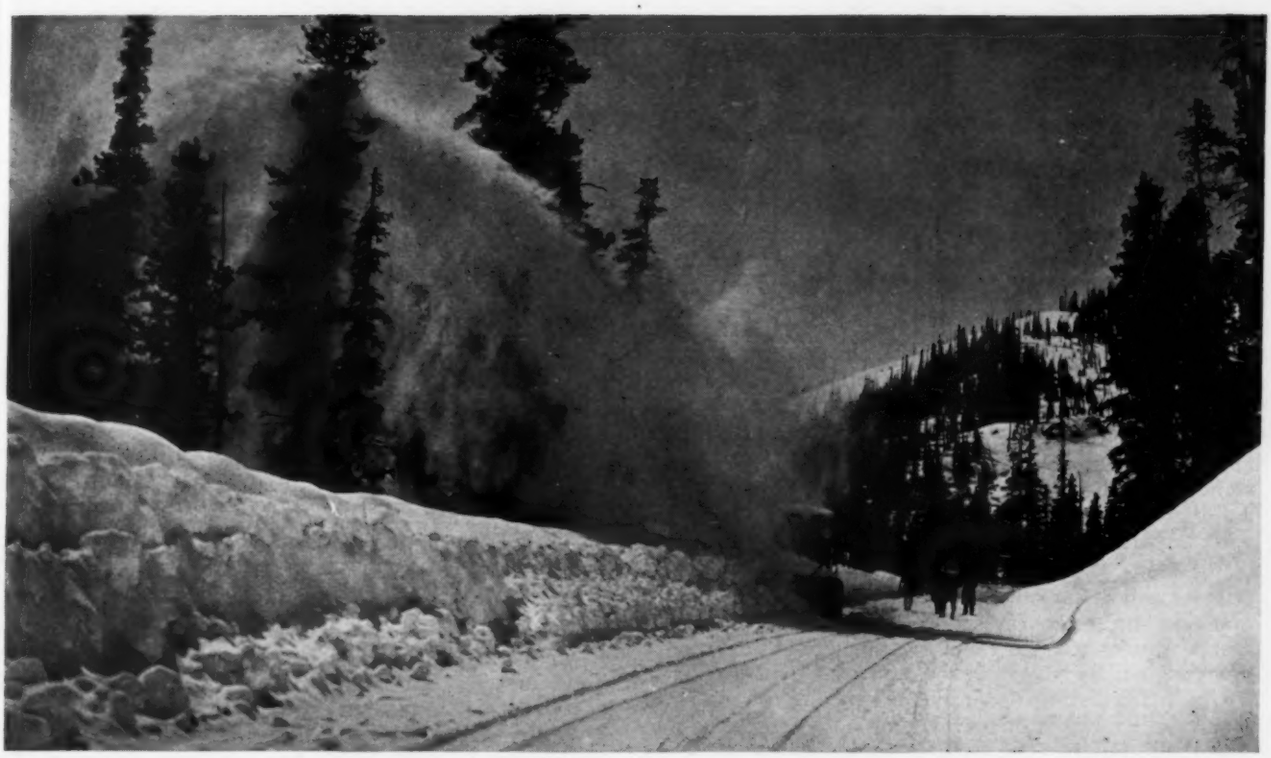
1900 MILES OF GERMAN AUTOMOTIVE HIGHWAYS IN SERVICE—At the end of April, 1904 miles of the network of national highways (Reichsautobahnen) of Germany were in service. Under construction at that time were 1135 miles. An average of 112,412 men were employed on this project in April.



Rotary Plow in Action on Cleaning and Widening Work on Berthoud Pass Forest Highway, Colorado.

SNOW REMOVAL IN ROCKY MOUNTAINS

By CLYDE E. LEARNED
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THE distance from the Kansas state line to the Utah state line on U. S. 40—the most popular and heaviest traveled transcontinental route across Colorado—is 500 miles. Although the Continental divide meanders across Colorado in a general north and south direction, numerous topographic kinks require U. S. 40 to cross the Continental Divide three times. The first crossing is at Berthoud Pass, approximately 60 miles west of Denver, at an elevation of 11,306 ft. The second and third crossings are only four miles apart, the second being Muddy Pass, and the third, Rabbit Ears Pass, at an elevation of 9,611 ft., approximately 30 miles northwest of Kremmling and about 160 miles west of Denver.

The key positions to an open-winter highway on U. S. 40 are the heavy snowfall regions adjacent to Berthoud and Rabbit Ears Passes. For the eighth consecutive winter the forces of the U. S. Bureau of Public Roads have kept the 30 miles of the Berthoud Pass Highway open between Empire and Fraser. Last winter was the third the Bureau had kept the 21 miles of the highway over Rabbit Ears Pass open to travel from Muddy Pass west toward Steamboat Springs.

Snowfall

The average winter snowfall during the past seven years on Berthoud Pass has been 420 in. During the winter of 1932-33 a maximum snowfall of 507 in. was recorded. The minimum annual snowfall recorded was during the winter of 1933-34, when 316 in. fell. Although Rabbit Ears Pass is approximately 1,700 ft. lower than Berthoud Pass, the snowfall for the last two winters has been about 20 per cent greater than that on Berthoud Pass, the fall for the winter of 1936-37 having been 506 in. and that for the winter of 1937-38, 490 in.

During the past two winters the Bureau maintained open highways on two sections of Colorado's scenic Peak-to-Peak Highway. At Allens Park on the South St. Vrain approach to Rocky Mountain National Park the snowfall was 171 in. and on the Nederland-Blackhawk project near Nederland it amounted to 137 in.

A few years ago it was commonly thought that March and April were usually the months of heaviest snowfall. Our records continue to bear out this impression, but not very conclusively nor with any degree of certainty. From the data now available, it appears that any of the Winter months may have the heaviest snowfall. Monthly snowfalls of 12 to 13 ft. have been recorded on both the Berthoud Pass and the Rabbit Ears Pass Projects. The greatest snowfall for an individual storm, which extended over a 3-day period, was 96 in. During one February storm, between 13 and 14 in. of snow fell in a 2-hour period.

Snow Mat Formation

Although snow plows are constantly moving snow from the roadway, a snow mat builds up under traffic in the high altitudes. Following intervals of sunshine or warmer weather, these snow mats compact and often become smooth and slippery. Naturally the first thought is to provide a non-skid surface by treating the smooth surface with an abrasive material such as sand or a mixture of sand and salt. At lower elevations where the snowfall is light and the slippery sections are usually short, this is what is done. On the South St. Vrain Project, particularly in the canyon sections, a large part of the Bureau's snow-removal cost is in connection with sanding operations. However, such a procedure in the regions of excessive snowfall is costly and usually futile because either new snow or wind will quickly nullify the action of the abrasives. A study of the Berthoud Pass and Rabbit Ears Pass daily snowfall reports show that snow often falls on every day of five to eight day periods and that during the 5-month period between December 1 and May 1, snow is to be expected on nearly one-half of the days.

Inasmuch as spreading abrasive materials to provide a non-skid surface appears impracticable at high altitudes, Bureau forces use the regular blade graders to remove and roughen the snow mat on every favorable occasion. To facilitate cutting down and roughening of the snow mat, saw-like blades or scarifiers are attached to the regular road graders. The teeth or cutting points are about 3 in. long and are spaced about 3 in. from center to center. The tips are treated with stelite to reduce wear.

Snow Fences

A number of permanent barriers have been constructed in an effort to control or reduce drifting. The major portion of the control work, however, is accomplished with temporary fences, usually the wire-connected slat type, which may be shipped in rolls, and which is easily installed and taken down for summer storage. At some locations this type of fence has been erected to a height of three tiers or 12 ft., by adding the second and third tiers as the lower sections became buried in the snow. On account of the terrific wind and great depth of snow encountered, a change has recently been made in the methods of the erection and tactical use of this type of fence on Rabbit Ears Pass. Present practice is to erect the first tier of fence in the usual way or to build up a snow ridge on which the fence is anchored. As the snow builds up to the top of the fence, a crew of men working on snowshoes jacks the fence up to the new surface of the drifts. This procedure is repeated every week or two during the winter. On occasions this type of fence has been jacked up to heights varying from 24 to 28 ft. above the surface of the ground. The fence is held in place by aspen poles which are inserted in holes dug in the packed snow with post hole diggers. Depending upon topography and wind conditions, this type of fence is usually from 100 to 600 ft. back from the highway. In some locations, two and sometimes three rows of parallel fence have been erected. The rows are spaced so that there is no overlapping of drifts. On stretches where the prevailing wind sweeps across the highway in a more or less quartering direction, efforts have been made to alleviate drifting on the highway by excavating trenches in the snow at right angles to the prevailing wind. These trenches or troughs were made between storms with the rotary plows and their use was necessarily limited to windswept exposures on which the terrain adjacent to the highway is nearly flat. Although these trenches caught a large amount of snow and appeared to retard wind action, it was felt that the benefits were not equal to the cost of the work involved; consequently, the snow-trench method of control has been abandoned.

Snow Removal

In regions of heavy snowfall the success of a snow-removal program is summed up in the words "Preparation and Readiness." Where heavy snowstorms are expected and preparations for these have been made, the job is usually accomplished without much delay, confusion, or additional expense; however, to be caught unawares without the necessary equipment and organized crews is indeed unfortunate.

For the actual removal of snow from the highway, the Bureau depends for the most part on heavy-duty 4-wheel-drive trucks which are capable of fairly high speeds. Since most of the snow must be pushed or thrown over the outside edge of the highway and down the mountain slopes, all trucks are equipped with front-mounted, reversible-type blade plows. In addition to the regular headlights, all trucks are equipped with two powerful spotlights and a large siren. The latter is used freely during periods of low visibility and when the equipment is working on curves and the sight distance is short, or when the crews are plowing on the wrong side of the highway. To caution traffic regarding the movement of snow-removal equipment on the wrong side of the road, large signs have been erected in conspicuous places on the approaches to these heavy snow-removal projects. In large, bright letters these signs state that within the next 30 miles of highway, at any time or any place, snow-removal equipment working on the wrong side of the road may be encountered; and for this reason, the driver is asked to drive with caution and to be prepared to stop. During the first few years of our snow-removal operations numerous accidents were caused by fast drivers slamming on their brakes and sliding into the snow-removal equipment. Apparently most drivers now know about snow-removal operations on these passes and the number of this type of accident has been reduced.

On the Donner Summit Route on U. S. 40 in California, when a storm gets under way or when the road is icy and dangerous, patrol officers stop automobile drivers and require them to put on skid chains before they are permitted to proceed. This practice has as yet not been enforced in Colorado, but as traffic increases on mountain highways, it becomes increasingly evident that similar regulations will have to be put into effect.

Variation in Snow-Removal Procedure

Snow-removal procedure varies somewhat as the winter advances and the depth of snow increases. Usual practice during the forepart of the winter to the middle of January is to use fast-moving heavy-duty trucks with push plows to clear the traveled portion of the road. A small windrow of snow is usually left along the outside shoulder to define the edge of the road. This outside definition is of material assistance to night drivers, and as the windrow is soon built up it prevents motorists from sliding off the highway.

While plowing dry powder-like snow not to exceed 12 in. in depth, the speed of the 4-wheel drive trucks is limited to 18 or 20 miles per hour. At higher speeds the driver's vision is impaired by the whirling cloud of dry snow. In compact or wet snow up to 8 in. depth, speeds of 25 miles per hour are attained. This is considered to be the maximum speed a truck with a snow plow should be permitted to travel on a mountain highway.

Crews Erecting Slat Type Snow Fence on Packed Snow Drift on Colorado-Rabbit Ears Forest Highway. Fence Is Raised as Snow Builds Up Around It.

A different procedure is adopted when winter advances and snow accumulates to a depth that prevents disposal by truck plows. Truck plows are used to move the fresh snow across the roadway to the outside, where it is piled in a secondary windrow adjacent and parallel to the windrow which was previously established along the outside shoulder. When the truck plows have built up a sizable secondary windrow, rotary plows are used to pick up the windrowed snow and blow it away from the highway. The speed of the rotaries on this class of work varies from 1½ to 2 miles per hour. The speed of the rotary is reduced to about ½ mile per hour if packed snow is to be moved.

Occasionally there is a snowfall which drifts and packs so hard, or is so wet and heavy, or freezes so tightly that push plows cannot handle it. Rotaries are then relied on to open the road to travel.

Organization

Unquestionably the most important task in connection with a snow-removal program is the selection and organization of the crews. The best and most expensive snow-fighting equipment is of no value unless dependable, skilled and aggressive workers man and operate it. The men in the snow-removal crews are the pick of the Bureau's maintenance organization and are selected because they are physically fit, respond in an emergency, have nerve and initiative, cooperate and get along well with one another, do not pass the buck, are courteous to the traveling public, and are keenly alive to the fact that no matter how severe the storm may be, they have an important job to do and there must be no failure.

When it is realized these men are bucking snow, battling gales, and outwitting cold night after night on highways on which the visibility is practically nil, and it is necessary to stop every few feet to get their bearings, one can appreciate why men with the above mentioned qualifications are so essential to a successful snow-removal program.

Rabbit Ears Pass

Although the snow-removal operations on the Berthoud Pass Project are exceedingly difficult at times, the ten miles of highway in the open and sparsely timbered region across the Rabbit Ears Range presents the Bureau's most difficult snow-removal problem. The snowfall on this ten-mile section is about 500 in. annually; however, the heavy fall of snow is not indicative of the enormous amount of labor that is required to keep this section of highway open to travel. Directly adjacent to the pass is a two-mile stretch of highway across a treeless expanse which appears to bear the brunt of the terrific concentration of winds on the Rabbit Ears Pass and which during storms requires the most intensive and aggressive methods of snow fighting. It is often necessary to keep one or two truck plows with occasional assistance from the rotary on this stretch of highway and to carry on continual snow-removal work.

On a few occasions the wind and the snow have been so severe that wet snow piled in on the motors and short-circuited the ignition systems, thereby tying up the Bureau's snow-removal equipment. At such time the gates at both ends of the project were closed and traffic stopped until the storm abated.

In an effort to reduce snow drifting on this troublesome section of highway, additional grading has been done to flatten and otherwise treat, cut and fill slopes so as to create air-flow sections, i.e., sections which introduce a minimum interference or resistance to air currents. A large amount of snow fence has been found to be indispensable on this particular section of highway.

Costs

When the U. S. Bureau of Public Roads first proposed to keep Berthoud Pass and then Rabbit Ears Pass open, there was a general feeling that it would be impossible to keep a transcontinental divide pass open throughout the winter. The project was considered to be more or less of an experiment, and it was believed that the first severe winter would demonstrate it to be unfeasible. There was also discussion as to whether the traffic benefited would justify the expenditures involved. The cost of keeping Berthoud Pass open to winter travel averages about $16,000 per year, and that of Rabbit Ears Pass about $18,000. The distribution of these costs for the 5-month period from December 1, 1937, to May 1, 1938, follows:

		Pct.
BERTHOUD PASS—30 miles.		
Labor costs, including annual and sick leave for employees	$ 8,348	52
Materials and supplies, including gas, oil, explosives, and minor repairs and parts	3,146	20
Equipment rentals, to cover depreciation and overhauling	4,403	28
Total	$15,897	100
RABBIT EARS PASS—21 miles.		
Labor costs, including annual and sick leave for employees	$ 8,058	46
Materials and supplies, including gas, oil, explosives, and minor repairs and parts	4,106	23
Equipment rentals, to cover depreciation and overhauling	5,449	31
Total	$17,613	100

The crew on the Berthoud Pass Project includes a foreman, nine operators, a cook, and a camp man. On the Rabbit Ears Pass the crew is the same except that one additional operator is employed. Approximately $5,000 or 15 per cent of the total snow-removal expenditure was for gasoline.

The snow-removal season is estimated to cover a 5-month period from Dec. 1 to May 1. Snow-removal costs before Dec. 1 or after May 1 are charged to regular maintenance operations. Minor repairs are made in the garages on the projects, but major repairs or overhauls are made at the Bureau's central equipment depot in Denver, where skilled mechanics and the necessary machines and tools are available for speedy repair work.

Unquestionably snow-removal operations on the Continental Divide passes on U. S. 40, as well as on other highways, have stimulated winter travel, with a resulting

The Fence Has Been Raised by Approximately 4 Ft. Lifts to a Height of 28 Ft. Above Ground Surface

increase in highway income. If it were possible to segregate all revenue collected from gasoline taxes as a result of keeping U. S. 40 west of Denver open to travel, it would be found that the income from this source alone is in excess of the cost of snow-removal operations. Furthermore, the maintenance of an open highway on U. S. 40 throughout the winter permits greater use of the highway construction investment as well as the investment in motor vehicles; it also reduces annual spring maintenance expenditures and creates a more efficient transportation system.

Acknowledgment—The foregoing is an abstract of a paper presented at the 1939 Highway Conference at the University of Colorado.

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BITUMINOUS MATERIALS AT A.S.T.M. MEETING

FOUR technical papers and two committee reports featured the Thirteenth Session of the annual meeting, June 26 to 30, of the American Society for Testing Materials.

Sieve Analysis of Mineral Filler—Committee D-4 on Road and Paving Materials included in its report two items for information, one covering method of test for sieve analysis of mineral filler which will be recommended to the Society for acceptance during the summer. Some of the data required in this method resulted from a series of cooperative tests, the results from the twelve laboratories being given in the report. Reasonable value for agreement between different laboratories was 2.0 per cent for the No. 200 sieve and 1.0 per cent for No. 80 sieve. Since satisfactory specific requirements for emulsion for use in densely graded cold asphaltic mixes are in great demand, proposed specifications have been prepared. While the committee is not yet prepared to recommend them for acceptance by the Society, the proposals are published in the report as information.

Expansion Joint Materials—Active work under way for a number of years on expansion joint materials finally resulted in two new tentative standards, one covering methods of testing preformed expansion joint filler for concrete and the other item giving specification requirements.

Thermal Susceptibility of Asphaltic Mixtures—Roland Vokac, Barber Asphalt Corp., outlined in his paper some factors affecting the thermal susceptibility of asphaltic paving mixtures. The compressive strength of asphalt mixtures at various temperatures was used to evaluate a mixture susceptibility index. Thermal susceptibility was found to vary with mixture composition, kind of asphalt cement used in the mixture, and temperature of the mixture. It is shown in comparable mixtures that the thermal susceptibility of the mixture varies according to the thermal susceptibility of the asphalt cement. The author concluded on the basis of test results that in order to obtain mixtures having similar physical characteristics such as susceptibility, strength, voids, etc., using asphalts from different sources, the mixtures must be proportioned individually to suit the unique characteristics of each asphalt.

Adhesive Properties of Asphalt—In the paper evaluating the adhesive properties of asphalt by August Holmes, Standard Oil Development Co., this property or ability of an asphalt to resist being displaced by water from an aggregate has been defined as its "adhesivity" in contradistinction to "adhesiveness," which is considered to be the mechanical strength by which an asphalt clings to the aggregate. The author pointed out that the asphalt must not only act effectively as a binder for the aggregate to produce a surface capable of bearing traffic but it should also maintain its binding properties under the deteriorating effects of moisture and weather. Various small-scale laboratory procedures have been developed to investigate methods of adhesivity properties and circular track tests were made. From the latter it appears that by the use of suitable wetting agents in the asphalt, relative improvement in pavement life up to 3.88 times that of untreated asphalt can be obtained.

Research in Soil Stabilization—There was rather critical discussion of the paper describing research in soil stabilization with emulsified asphalt which was presented by C. L. McKesson, Director of Engineering and Research, American Bitumuls Co. Various test methods to determine soil constants by which the efficiency of stabilization could be measured were described, two of the tests, the absorption test and the stability test, having come into general use. A number of questions on the tests were raised by Raymond Harsch, Shell Oil Co.

Degradation Produced by Rollers—T. E. Shelburne, Research Engineer, Joint Highway Research Project, Purdue University, furnished data on the degradation produced by 5-ton and 10-ton rollers in compacting typical surface treatment aggregates both on a bituminous mat and on a concrete base. From the studies made he concluded that both under construction procedure and under traffic, mineral aggregates follow a fixed manner of degrading. The amount of this degradation depends upon the work exerted upon them.

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TRUCK PRODUCTION BY CAPACITIES—The following tabulation from the July 1 issue of the Automotive World News, a publication of the U. S. Bureau of Foreign and Domestic Commerce, shows the per cent truck production by capacities for the United States and Canada for the past four years:

Truck Tonnage	1935	1936	1937	1938
¾ ton or less	34.1	38.6	41.7	39.2
1 ton and less than 1½	.3	1.1	2.3	3.0
1½ ton and less than 2	57.5	52.0	48.6	47.7
2 ton and less than 2½	4.0	3.7	3.2	3.2
2½ ton and less than 3½	1.4	1.5	2.0	1.8
3½ ton and less than 5	.5	.5	.6	.9
5 ton	2.2	2.6	3.6	4.2

CONTROL OF ICY CONDITIONS ON ROADS

Summary of Practice of State Highway Departments of 24 States

Arizona

The state highway department carries out ice control measures only on several short stretches of highway, about 3,000 ft. in all. Volcanic cinders treated with calcium chloride are spread by hand from 1½-ton and 2½-ton trucks.

Connecticut

The care of icy conditions is under the regular personnel of the bureau of maintenance, and is carried out in connection with snow removal and at all other times when such conditions exist. Material is a quality of sand of sufficient granular nature to furnish traction. Under certain conditions of shade or lack of sunlight penetration, calcium chloride may be used to afford more adhesion of the sand to the surface. It is not the custom to mix chloride with all sand utilized for icy pavements. When these conditions may exist it is customary for each truck to be loaded with sand previous to garaging for the night so that material may be available immediately when necessity arises. Additional sand supplies are located as frequently as possible along the highways for the reloading of the trucks as quickly as possible. The sand is distributed from highway trucks by hand methods.

During the winter of 1938-39 ice control measures were carried out on the entire state highway system of 2,775 miles. The total cost of the ice control work was $344,667, divided as follows:

Sanding icy pavements	$296,896
Removing ice from pavements	37,848
All other work on snow and ice	9,923

Illinois

The treatment of icy pavements on the state highway system in Illinois is handled by the usual method of scattering abrasives, such as, cinders, sand, finely crushed stone, and crushed slag over the pavements. A small amount of calcium chloride is incorporated in the stock piles of cinders placed along the highway.

The scattering of abrasives has been confined almost entirely to steep grades, sharp curves, paved intersections, railroad crossings, and other hazardous locations. The abrasives are spread both by mechanical means and by hand from maintenance trucks. Employees are required to start this work as quickly as ice formations appear at any time during the day, night, or holiday. The mileage of pavements and the impracticability of covering the entire state highway system, as well as the cost, prevents extending the work over the entire mileage of highways affected.

Ice formations in this state oftentimes appear and disappear within a space of a few hours' time. It has been common experience to have the icy condition melt away before the workmen have completed the scattering of abrasives on the locations under their individual charge.

Indiana

The total state highway mileage is 9,697. During the past winter ice control measures were carried out on 9,289 miles. Calcium chloride treated cinders and sand were applied on hills, curves and stop intersections. The state owns 552 snow plows and 302 sand spreaders.

Iowa

During the past winter ice control was carried out on curves and hills only. The treatment was made with sand or cinders to which calcium chloride had been added. This is only a temporary relief and the maintenance department concentrates on actually removing the ice from the pavement as soon as it softens up so it can be cut with a heavy blade machine.

The following state maintenance equipment is available for use on ice control:

Trucks 1½ tons or less	449
Trucks over 1½ tons	243
Power maintainers	242
Blade graders	381
Sand spreaders	300

Maryland

The ice treatment program in the state is considerably lessened by getting out snow plow equipment as soon as possible, in order to prevent compaction of snow on the road by traffic.

All intersections, for a distance of 200 ft. are cindered. Steep grades and dangerous curves and all sections of road where sudden brakeage may be required, are given attention. The more important roads are given preference in this treatment.

Spreading of cinders, sand and granolithic material is supplemented by mechanical spreaders. Stock-piles of material are placed prior to the winter season at points where experience has shown to be in need of special attention of this character. These stockpiles are treated with approximately 50 to 60 lb. of calcium chloride per ton of material.

The state highway system consists of 4,100 miles and ice control measures carried out on the entire system.

Massachusetts

In controlling icy and slippery conditions on state highways in Massachusetts during the past winter, the treatment of icy surfaces was the major part of the work performed.

During the past winter there were 57 days when it was necessary to continually sand the highways. This work is carried out by the regular maintenance and snow removal organization in the same manner as in effect

the past few years. The amount of this work is constantly increasing. During the past few years, particularly with the construction of the heavily traveled, high-speed, super highways such as the Boston-Providence Pike, Route 1; the Boston-Worcester Pike, Route 9, and the Newburyport Pike, Route 1, the motoring public is almost demanding that the entire roadway be sanded at all times. This has necessitated increased operations on these highways with a resultant increase in expenditures.

The sand used is ordered in the fall and stockpiled at convenient points along the road particularly where there are hills, curves and intersections. Wherever possible in the vicinity of large cities, sand is purchased from commercial plants and loaded onto the trucks at the plant during storms. This speeds up operations in these localities. All state-owned units on this work are equipped with mechanical spreaders and the major part of the hired trucks used are also equipped with the same.

During this past season the use of portable loaders at convenient points where the highway radiates in two or three directions and where a sizable stockpile can be placed has speeded up the loading and application of sand on these areas tremendously. There will be without doubt an increase in the use of such loaders during the next few years.

With the heavy-duty plows used on the four-wheel-driven units the roadway surface is plowed almost bare during the storms, and immediately following the storm, drainage structures and waterways are cleaned out to carry off surface water so that it does not remain on the roadway surface with resultant freezing.

The total mileage of state highway is 1,891 and ice control measures were carried out last winter on 1,798 miles. Sand is applied on all hills, curves, tangents or high-speed roads and at other locations where a particularly dangerous condition exists. Sand is used entirely for the abrasive material. Calcium chloride or sodium chloride to the maximum amount of 100 lb. per cubic yard is added to the sand.

The equipment used last winter in applying the sand consists of 129 4-wheel-driven units ranging in size from 2 to 10 tons, 110 1½ ton trucks, 260 mechanical spreaders and 9 portable loaders. All this equipment is owned by the state. In addition there were 400 hired trucks and approximately 240 hired mechanical spreaders.

There unquestionably was a reduction in traffic accidents due to ice control, but definite proof of this cannot be given as comparative records are not available.

Michigan

Ice control measures were carried out during the last winter on the entire bay state highway system of 9,200 miles.

The methods employed consisted of sanding with a mixture of calcium chloride. On gravel and black top roads a finely crushed rock salt was used. The rock salt was not mixed with sand, but was applied clear. One innovation used quite extensively during the past winter was a new type of blade, called a "serrate" blade. This was used to score the snow-ice and soft ice where possible in order that the mixtures of calcium chloride and sand would be held on the ice, instead of being blown off on the side of the road. This proved quite effective.

The equipment used in snow removal and ice control work included 506 trucks with plows, 155 tractors with plows, 39 graders and 7 power shovels. In addition 3,901,550 lin. ft. of snow fence was employed.

There was a reduction of 30 per cent in traffic accidents last year on the state highway system, and it is felt that a great deal of this was due to the fact that the state highway department sands straight-of-way, as well as curves and turns.

Minnesota

Ice control measures were carried out last winter on the entire highway system of 11,208 miles. The total expenditure for ice control work was $251,108.

The methods employed consisted of limited blading and sanding, especially icy intersections and hills. The equipment used consisted of rotary sand spreaders and other commercial type. Sand or fine gravel, 25-30 lb. per cubic yard sand, were used.

The state equipment used for snow removal and ice control consisted of the following:

Type of Equipment	Number of Pieces
Snow Plows	531
Wings	293
Rotary Snow Removers	13
Trucks	443
Tractors	30
Motor Graders—Power Patrols—not all used for snow plowing	145
Sand Spreaders	79

Increased attention to the sanding of icy roads was ascribed by the Highway Safety Department as one of the factors in reducing traffic death toll during the first two months of 1939 from 77 in the same period last year to 54 this year.

Missouri

Ice control measures are carried out on approximately 10,000 miles of the 15,395 miles of the state highway system. Curves, hills and bridge floors are covered with cinders, sand, chat or gravel, which in most cases had been treated with calcium chloride. Trucks, shovels and mechanical material spreaders were used.

Montana

During the past winter ice control measures were carried out on the entire 4,840 miles of state highway system. The total expenditures for this work were $31,000.

Material is stockpiled in fall at strategic points and sand bins are filled in readiness for use, particularly in mountainous sections. Snow plows are operated with cutting edges as close to surface of roadway as possible in order to remove all snow possible and to prevent slippery sections forming due to alternate freezing and thawing temperatures.

Sand and cinders are used, the latter being preferred. Most sanding is done by hand spreading from trucks, one man doing the spreading. In addition 28 department made sand spreaders attached to 1½-ton trucks are used.

Nebraska

During the past winter there were under maintenance 8,690 miles of state highways, of which 2,713 miles were paved. The treatment of icy surface is not carried out on a very broad scale by the department and only on pavement. This is for the reason that icy surfaces do not generally prevail for any length of time.

The usual procedure has been to stockpile cinders or other desirable aggregate in small piles at short intervals near the shoulder at those places where it would be particularly hazardous when the surface is icy, such as steep grades, sharp curves, and approaches to narrow structures. When the material is stockpiled on the shoulder, it is spread by hand directly to the surface from the stockpiles.

Aggregate mixed with calcium chloride also is stockpiled at three or four patrol headquarters in that section of the state where considerable pavement exists and the roads are somewhat hilly and winding. When needed, material is hauled from the stockpiles by truck and spread on the surface with mechanical spreaders which are attached to the rear of the truck. To date sanding of any continuous sections of highway has not been undertaken, this type of working being confined to small sections or spots where the condition is most hazardous.

Approximately $5,000 per season is spent for this type of work.

The only special equipment consists of three small rotary spreaders which are attached to the rear of the trucks.

New Hampshire

Of the 3,480 miles of the state highway system, ice control measures were carried out in the winter of 1938-39 on 2,720 miles. Chloride treated sand is spread on the icy surface. Chlorides were used to prevent freezing of stockpiles. The sand was applied by truck drawn mechanical sanders mostly of the trailer type. Occasionally there was some hand sanding from trucks. The total cost of winter maintenance including snow removal and sanding was $981,752.

New Jersey

The snow removal program during the 1938-39 season covered a total of 1,593 miles and ice control measures were, when necessary, carried out on all portions of the program. The total expenditure on snow removal and ice control for the season amounted to $440,594.95, which includes, in addition to snow removal and ice control, the erection and removal of snow fence and the opening up of drainage structures following a storm. Last season was the first time that the highway department had any considerable quantity of equipment for the applying of abrasives. During the winter it acquired 32 new spreaders, which supplemented six old spreaders, making a total of 38 spreaders used for this purpose.

For the last two years, particularly in the northern end of the state, the department has maintained all night patrols when weather conditions were such as to indicate the probability that slippery conditions would develop. If, however, weather conditions are such that ice formation is not expected, patrols are not maintained but the forces are on call upon notification that dangerous conditions are developing and they are immediately called out to take care of the work.

The program, as a whole, does not contemplate a complete covering of all pavements but merely the treatment of important intersections, grade separations, traffic circles, steep grades and curves. The material used consists, for the most part, of cinders, although considerable quantities of stone sand and ordinary sand are used in places. These abrasives are, to a considerable extent, used with an admixture of calcium chloride, except on the Pulaski Skyway, where no chemicals are used by reason of the possibility of damage to the steel structures. Where spreaders are not available, spreading is done by hand either from small piles spotted along the road or from trucks which travel along the road.

New Mexico

Snow removal and ice control are not a great problem in this state ordinarily. The past year, however, was an exception. The snow removal cost was within $700 as much as for the five previous years. The total cost for the season was $65,705. Sand spreaders, of which 5 are owned by the state, attached to trucks were used for sanding ice places. The equipment used for snow removal included 12 pull type graders; 7 push type V-plows for tractor or motor patrol; 1 rotary plow and truck; 34 motor patrols and 36 trucks and pickup.

New York

On January 1st of this year there were 12,675 miles of improved state highway under maintenance in this state. During the calendar year of 1938, 5,068 miles of state highway were treated to eliminate conditions caused by ice on the pavement, at a total expenditure of $950,000. This work was carried out by the use of necessary labor, foremen, and motor trucks in the application of sand, cinders, and stone screenings with a mixture of sodium chloride and calcium chloride, to the pavements upon which ice was forming or had been formed. The equipment used in general consisted of motor trucks to which were attached mechanical sand spreaders, of which a large number are owned by the state.

Ohio

In the winter of 1938-39 ice control measures were carried out on the entire state highway system of 16,400 miles. Cinders, sand, calcium chloride and sodium chloride were used. The total cost of snow removal and ice control was $927,318. The snow removal and ice control equipment owned by the state included the following:

Trucks, 779; displacement plows for trucks, 773; rotary plows for trucks, 6; graders, 490; power shovels, 40; 888,450 lin. ft. snow fence.

Oregon

For at least the past 18 years the state highway department has been sanding all icy pavements. About four years ago sanding machines were constructed in the state highway shops to facilitate the sanding of icy pavements. At this time there are approximately 100 machines in use throughout the state. During the winter months night crews are working on those sections where ice forms regularly.

Pennsylvania

The total mileage of the state highway system is 40,482. Snow removal and ice control work were carried out on 18,577 miles of the system during the past

winter. The maintenance forces performed cindering operations day or night as needed. The equipment stored conveniently near to troublesome areas starts operating when ice occurs and when the fall of snow has reached a depth of 2 in.

The materials used in the ice control work are cinders, coarse sand, granulated slag and stone screenings. The latter are graded from ⅜ in. size to ⅛ in. size. In addition to these materials, the stockpiles of anti-skid material are treated with calcium chloride to prevent freezing.

The total cost of snow removal and ice control work the past winter was $4,894,842.

The snow removal equipment owned by the state is as follows:

Number of Units	KIND OF EQUIPMENT
424	Rerversible type plows—Mounted on 1½-ton conventional type trucks
27	Reversible type plows—Mounted on 2-ton conventional type trucks
132	Heavy duty reversible type plows—Mounted on 3-ton conventional trucks
74	Heavy duty reversible type plows—Mounted on 3-ton four-wheel type trucks
43	Heavy duty reversible type plows—Mounted on 5-ton four-wheel type trucks
317	One-way trip and rigid type plows—Mounted on 3-ton four-wheel drive type trucks
14	One-way trip and rigid type plows—Mounted on 5-ton four-wheel drive type trucks
51	"V" type plows—Mounted on 3-ton four-wheel type trucks
25	"V" type plows—Mounted on 5-ton four-wheel drive type trucks
18	Rotary type plows—Mounted on 5-ton four-wheel drive type trucks
78	Tractors equipped with "V" type plows
26	Tractors equipped with rotary type plows
109	Power graders equipped with "V" type plows
8	Power graders equipped with heavy duty reversible type plows
1	Snow loader

Utah

Total mileage of state highway is 5,106. During the past winter approaches to semaphored intersections and to railroad grade crossings and canyon curves on about 1,000 miles of road were sanded as required.

Virginia

As the winter of 1938-39 was mild, ice control measures were carried out on only approximately 30 per cent of the 9,388 miles of the state highway system. In this work patrolmen watch weather conditions closely and on the slightest indication of ice forming they start their trucks, which in most cases are equipped with chip spreaders.

The materials used are cinders, coarse stone dust and sand, with admixture of calcium chloride or salt at the rate of about 75 lb. to 100 lb. to the ton.

Washington

Throughout the winter 1938-39 there was spent for snow removal on the highways of this state a total sum $451,146.97. The snow removal program embraced in 1938-39 a total of 5,900 miles. This mileage would be classified as 4,915 miles of light snow removal, 850 miles of medium snow removal and 135 miles of heavy snow removal. The practices for the control of icy and slippery conditions consisted very largely of sanding, sand being applied most generally through medium of mechanical spreaders. In some localities salt was used to an extent and in other localities calcium chloride. In both cases the application of these chemicals was by mixing same with sand.

West Virginia

A total of 34,328 miles of highway are under the jurisdiction of the state highway department. This total is composed of 4,776 miles of primary system and 29,552 miles of secondary system. During the past winter ice control measures were carried out on portions of 4,500 miles of highway. The work consisted in plowing and application of cinders, sand, sawdust slag, calcium chloride and sodium chloride. The applications were made with cinder spreaders.

Wyoming

Wyoming has 3,373 miles of state highways. No definite length or system has been set up for ice control measures, as the department is just entering into this phase of winter maintenance.

The maintenance men sand the hills and bad curves, using local sand, coal slack or cinders. At times practically all the highways in the state are coated with ice and it is impossible to do any more than take care of the hills. Piles of coal slack, cinders or sand are left adjacent to some of the worst hills in order that truck drivers may use these materials in emergencies. Experiments have been made in a small way with sand mixed with calcium chloride, and it is expected to do more of this work in the future.

For sand spreading regular maintenance trucks are used, and in some cases the sand spreaders employed in spreading sand on seal coat in the summer are used for the winter work.

How Members of the Illinois Road Builders' Association Fight Diversion of Gas Taxes. Signs Like This Are Placed on the Construction Jobs of the Contractors Belonging to the Association.

BASE STABILIZATION ON SKYLINE DRIVE

SKYLINE DRIVE, the mountain-top highway in the Shenandoah National Park of Virginia, is nearing completion and will soon be open to travel from Front Royal to Jarmans Gap, Virginia—a distance of 97 miles. This is the first section of a mountain highway development that will eventually link the Shenandoah National Park with the Great Smoky Mountains National Park in North Carolina.

The section of highway which connects with Skyline Drive, designated as the Blue Ridge Parkway, is now under construction and progressing rapidly. By the summer of 1940 it is expected that a continuous stretch of more than 150 miles will be open to traffic, in addition to the mileage provided on Skyline Drive. When fully completed, the mountain highway will extend for almost 600 miles.

While the National Park Service has charge of development of the Parkway system, the actual work of survey, design and construction of the highway is being performed under supervision by the U. S. Bureau of Public Roads. Acquisition of the Parkway lands has been made a responsibility of the state highway departments.

A rather interesting phase of construction on Section 3-C-1 of Skyline Drive was the use of soil-aggregate stabilization in the preparation of the base course. This section, 4.426 miles in length, extends from Brown's Gap to Black Rock Gap, and is located near the southern end of the Drive. The grading and base course construction were performed under contract by Chandler Brothers, Inc., Virgilina, Va.

Starting in September, 1937, the contractor's first job consisted of rough grading, in which a number of large fills and deep cuts were necessary. Work on stabilization of the base course began in the late spring of 1938 and was finished in September, 1938. After a winter of seasoning, 1938-1939, the base course is now scheduled to receive final bituminous surfacing during the present construction season.

Stabilized Base as It Looked on May 3, 1939, After a Winter of Seasoning

Stabilized Base on Roadway and Parking Overlock, After Surface Application of Calcium Chloride

Materials and Specifications for Stabilized Base Course

Specifications prescribed for the base course on this project called for a final mixture that would fall within the following limits by weight:

Material	Per Cent
Passing 1½ in. sieve	100
Passing 1 in. sieve	85-100
Passing ¾ in. sieve	60- 90
Passing ½ in. sieve	40- 80
Passing No. 4 sieve	25- 60
Passing No. 10 sieve	20- 45
Passing No. 40 sieve (A)	10- 30
Passing No. 200 sieve (B)	0- 15

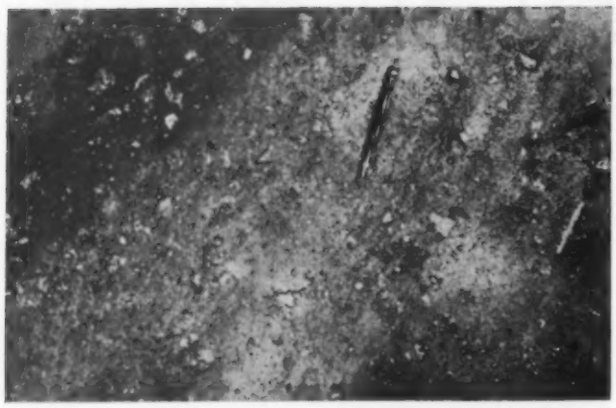
Ratio A to B — 0.32

Along the foot of a mountain just outside the parkway proper and about 4 miles from the highways project, a satisfactory deposit of quartzite and sandstone was located. Reduction of this material by means of a crusher produced a coarse aggregate mixture of which 100 per cent passed a 1¼ in. sieve, 40-60 per cent passed a ½ in. sieve, 25-35 per cent passed a No. 4 sieve, and not less than 25 per cent was retained on the No. 4 sieve.

With the source of coarse aggregate at hand, it was still necessary to secure binder-soil and additional fine materials in order to produce a final mixture that would meet specifications. By a fortunate circumstance, ideal material was found in a glacial deposit located in a nearby field. Though belonging under the general classification of sandy clay-loam, the profile of this particular deposit was quite unusual, consisting as it did of the following:

Depth	Nature of Material
From 0 in. to 6 in.	Grayish yellow sand
From 6 in. to 24 in.	Loose yellow sand
From 24 in. to 42 in.	Reddish yellow to reddish sticky sandy clay loam
From 42 in. down	Reddish yellow loose sand

By using the full profile of material from the surface down to a depth somewhere below 42 in., tests revealed



Close-Up of Stabilized Base

the resulting soil mixture to have a liquid limit of 18 and a plasticity index of 0. The gradation of this material was as follows:

	Per Cent
Passing No. 4 sieve	100
Passing No. 10 sieve	100
Passing No. 40 sieve	79
Passing No. 200 sieve	23

The combination of crusher-run coarse aggregate and fine material produced a final mixture of the following gradation:

Material	Test Results	Orig. Spec. Limits
	—Per Cent—	
Passing 1½ in. sieve	100	100
Passing 1 in. sieve	93	85-100
Passing ¾ in. sieve	70	60- 90
Passing ½ in. sieve	51	40- 80
Passing No. 4 sieve	36	25- 60
Passing No. 10 sieve	31	20- 45
Passing No. 40 sieve	22	10- 30
Passing No. 200 sieve	7	0- 15

That the gradation of materials came well within the prescribed limits can be checked by reference to the original specifications.

Construction Procedure

The stabilized base course was placed in two layers, each of 3 in. thickness and applied to the full 20-ft. width of roadway. The crusher-run coarse aggregate for the first layer was trucked to the job and windrowed alongside the roadway. After the fine material and binder-soil had been placed on top of the windrow, the whole mass was bladed onto the roadway and thoroughly mixed to insure a uniform composition. The mixture was then shaped up and evened, and compaction was obtained by routing trucks over the layer.

In placing the surface course, substantially the same procedure was followed. After the windrowed soil-aggregates for this top layer had been bladed onto the roadway, however, flake calcium chloride was added at a rate of ½ lb. per square yard for each 1 in. of thickness (1½ lb. per square yard for the 3 in. surface course). The soil materials and calcium chloride were then thoroughly mixed. After shaping and evening, a surface application of calcium chloride was made at the rate of ½ lb. per square yard. A total of 43 tons of calcium chloride was used in the base stabilization of this 4.426 mile section.

Construction operations on adjoining sections of the Drive permitted the routing of much truck traffic over the stabilized base during the fall of 1938 and spring of 1939. Consequently, the base course has attained a high degree of density during the seasoning period, and the engineers in charge expect that little base correction will be required when the bituminous surface course is applied this year.

Two additional sections of calcium chloride stabilized base have been placed under construction this year on the Blue Ridge Parkway—the mountain highway project that connects with Skyline Drive. The contract for one section, 11 miles in length, has been awarded to Ralph E. Mills, Frankfort, Ky., and is designated as Section 1-D-1 from Tye River Gap to Love. At the time this article was written, it was expected that the contract would soon be awarded for stabilized base construction on the other section, 10 miles in length and designated as 1-C-1.

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FINE GRADING AND FINISHING WITH SCRAPER

A small Carryall scraper was used by W. F. Robinson & Son, paving contractors, Owensboro, Ky., for fine grading and finishing between the paving forms on their 5.4 mile contract near Horse Branch, Ky. One of LeTourneau's small 4-yard Carryalls was purchased specially to handle the finishing and preparation of the sub-grade. The complete job consisted of grading, draining, and paving with concrete. Work on the initial grading and draining was sub-let to another contractor

Small Scraper Preparing Subgrade on Paving Job of W. F. Robinson & Son

and started on July 9. The paving operations proper were started by Robinson & Son on August 28th and completed October 21st.

The scraper was given the job of handling all of the final grading between forms. All excavation on the fill to the finished grade was handled by the one machine and one man. The scraper also was used on shoulder work, building up, shaping and finishing.

HOW A FAILURE WAS CORRECTED

Sawtooth Blade Invented for Tearing Up Old Stabilized Mat

By J. C. ROBERTS
General Foreman, District No. 8, Texas State Highway Department

THIS report covers the construction methods and procedures used in obtaining a bituminous stabilized mat by road mixing the natural soils and existing material and a quantity of selected sand and gravel with RO-3 [Texas Designation.—Ed.] road oil. Construction of this type was completed on a 3.5 mile section of Highway U. S. 83, beginning at the Fisher-Stonewall County line and extending north to the Double Mountain fork of the Brazos River in Stonewall County.

The grading and small drainage structures on this project were completed in May, 1932. During construction of the grading no consideration was given to soil selection for stabilization purposes, and the completed grading work was typical of the type of work being done at that time in West Texas. The soils on this section of road were classified from an A-4 to an A-7 type and the roadbed was constructed with these types of soils and was maintained as a riding surface. As is characteristic of these soil types, the road was rough and dusty during dry weather, slick, and, at times, impassable during wet weather. This road was used and maintained without further improvement until 1935.

During the construction of the approaches to the Brazos River bridge, a deposit of gravel and sand was encountered and was utilized by covering two miles of this project with 4 in. of this material. The maintenance of this section of the project was difficult as it was impossible to keep the material smooth even though it improved the stability of the road during wet weather. Because of this undesirable condition it was decided to improve the section by stabilizing the material with road oil. By the time the oil stabilization work was initiated, wind and water erosion and constant maintenance by blading had reduced the depth of the material to approximately 2 in. On the remaining 1.5 miles of the project only the unstable natural soils existed; and during the process of stabilization it was necessary to add more sand and gravel to this section than was necessary for the 2-mile section which previously had been covered with sand and gravel.

On June 15, 1937, the state highway commission made an appropriation for the improvement of this section of road by the use of oil stabilization. The initial work on the project was started on July 17, 1937, and completed on August 25, 1937, with the state highway department maintenance forces. The plans provided for the stabilization of existing materials with RO-3 road oil by road mixing. The road oil was to be applied at the rate of 1.5 gal. per sq. yd. and provisions were made for the addition of a reasonable amount of native sand for final mixing purposes. It was estimated that a stabilized mat 20 ft. wide and approximately 1½ in. deep could be secured under the above provisions.

Construction Methods and Procedures

The first operation in the construction of this project was done with a 60 h.p. crawler tractor and a 12-ft. blade. With this equipment the subgrade was brought uniformly to grade and typical section. In the next operation a windrow of material, which was loosened and pulverized by blading, was placed well outside the 20-ft. limits of the section to be stabilized. The windrows of material on each shoulder were considered ample to absorb the prescribed application of oil.

An application of 0.75 gal. of road oil, heated to an approximate temperature of 150 deg. F., then was given to the prepared subgrade. One of the previously described windrows of material next was bladed into the oil by the use of two pneumatic tired power-maintainers. The material was bladed back and forth across the roadway 10 or 12 times for the initial mixing. Because of the difference in grading and the variation in the type

General View of Completed Surface

Testing Depth of Stabilized Surface. This Sample Was 3.0 Ins. Deep.

of soils, there was considerable difference in the richness of the mixed material, even though approximately the same amount of material by volume had been added. Sections from 50 to 300 ft. long were entirely too rich, and adjacent sections were very close to the proper consistency. To bring the rich sections to the proper consistency, pit run sand and gravel were added. This material was secured from an old sand and gravel pit adjacent to the right of way, and was similar to the sand and gravel encountered during the construction of the approaches to the Brazos River bridge, previously mentioned. The grading limits of this material were from a maximum of 2½ in. to that of fine sand. A "salt and pepper shaker" method of adding this material to rich sections was followed until a uniform mixture was secured. It was very apparent that the addition of a large amount of this clean sand and gravel was necessary to absorb the excessive oil. After the sand and gravel were added the amount of mixed material in the rich sections became proportionately greater. It was considered desirable in the first course, or mixing operation, to secure a lean mix. A dry, lean material on the bottom of the completed mat, it was believed, would help to prevent any rolling or "corduroying" action from occurring later.

After a uniform mixture of desired consistency was secured, the roll of material was spread evenly over the subgrade with pneumatic tired maintainers. The edges were established by the use of string lines.

Upon completion of the first half of the mixing operation, the remaining roll of dry material was spread evenly over the mixed material and given the remaining application of 0.75 gal. of oil. The material for the last course was mixed in the same way as it was in the first operation. Rich sections resulted, due to grading and soil types, as they had in the first course. They were eliminated by the addition of sand and gravel as previously described.

After the second row of material had been mixed to what was considered a desired consistency, the operation of finishing was begun. In this operation, the edges were again lined with a string, the roll of mixed material was bladed back and forth in a manner which gradually let a small amount of material under the blade. A continuation of this operation resulted in a very small roll of oversize rock. The oversize rock, thus accumulated, was considered undesirable, and was carefully bladed off the finished section and wasted in the ditches. This oversize aggregate originated in the pit run sand and gravel which was hauled in and added to the mixture. Upon the completion of the spreading operation, the mat was rolled with a 5-ton flat-wheeled roller and the shoulders were reshaped. The project then was considered completed and was opened to traffic on Aug. 25, 1937.

Construction methods and procedures were new to all concerned, and the entire project was done more or less as an experimental job. The final cost reports reflected a unit cost of $1,414.24 per mile, or $0.121 per square yard. However, after having gained the experience of this type of construction, it is estimated that the cost of a similar project could be reduced to approximately $1,250 per mile.

After the work had been completed approximately 60 days and the road had been subjected to traffic and extremely hot weather, it was evident that the mixture had been left entirely too rich. Bleeding was profuse, and the stabilized mat became "corduroyed" and apparently had slipped on the base in many places, resulting in a very rough and unpleasant riding surface. Weather conditions prevented any further work on the project until July, 1938.

It was evident that the proper treatment was the addition of more sand and gravel. The problem of getting the mixture back into windrows in a pulverized state was of importance. During the few months that the mixture had been exposed to traffic and weather, a very hard crust had formed on the surface. The effort to cut the mat with the regular blade of a maintainer proved difficult and very unsatisfactory. It was impossible to keep the blade from slipping through the hard top crust and cutting the material out in large chunks. In order to overcome this feature, a "sawtooth" cutting edge was cut out of the maintainer blade. The teeth in the blade were cut 3 in. deep and 3 in. from point to point. This change in the cutting edge of the blade proved very satisfactory in getting the material into windrows and into a pulverized state again.

Additional sand and gravel were added and mixed until the mixture had a dull brown color and there was no free oil apparent. The same spreading and finishing procedure was followed as in the initial work, and the road was again opened to traffic in July, 1938.

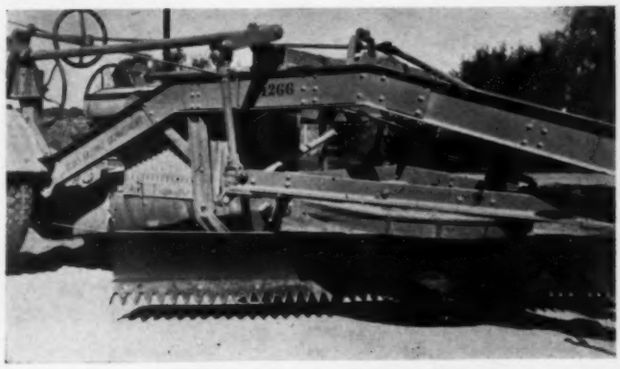
The second mixing and finishing operation was completed at a unit cost of $150 per mile.

Conclusion

After reworking the oil mat on this project in July, 1938, as described above, the resultant surface is far superior to that which we had anticipated when we first initiated this project. The addition of sand and gravel to the mixture increased the anticipated depth of the mat from 1.5 in. to an average depth of 2.8 in. The texture of stabilized mats of this type is usually of a "spongy" nature and without body. On this project, the addition of a maximum amount of coarse sand and gravel to the mixture has eliminated these undesirable characteristics, and has given body and stability to the completed mat. The resultant mixture is of such a nature that its characteristics are similar to those of asphaltic concrete. Furthermore, it has given the mat a non-skid surface, which is difficult to obtain in treatments of this type and which is always highly desirable. It is evident also that the sand and gravel have preserved and lengthened the life of the oil in the mixture. After 12 months of use, samples taken from the mat

show the oil to be as much alive and viscous as it was when the project was completed.

In the final mixture on this project, an application of one cubic yard of sand and gravel to 35 sq. yds. of stabilized mat was added to the existing soils and materials. It is estimated that this amount constitutes approximately 50 per cent of the materials mixed into the completed mat. By visual inspection no change can be detected in the qualities of the mat relative to the change in soil types.



The Specially Developed Sawtooth Blade

The mat in its present condition has been completed approximately six months. It has given service to approximately 450 vehicles per day, and has been subjected to varying weather conditions since its completion. Very little variation in the riding qualities of the mat can be noticed, and no failures of any kind have developed.

On Jan. 7, 1939, depth tests were taken of the completed mat and soil samples were taken from the subgrades immediately below the stabilized material. The samples indicate the type of soils used in the stabilized mat.

The results of this investigation are shown in the following table:

Sta. No.	Average Depth of Mat, Ins.	Soil Sample No.	Soil Class	L.L.	P.I.	L.S.,* Pct.	F.M.E.	Retained on No. 40 Pct.
25/20....	2.4	1	A-7	40	18	15	29	3.6
35/80....	2.6	2	A-7	41	22	15	30	7.2
70/10....	2.5	3	Gyp	..	..	1	..	67.3
149/40....	2.8	4	A-4	26	12	8	20	53.8
183/80....	3.0	5	A-7	39	19	15	27	5.2

*L. S. means lineal shrinkage.

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CIRCULAR TRACK TESTS ADHESIVITY OF ASPHALTS

The circular track for obtaining accelerated results with road materials has been in use for a number of years. A similar arrangement has been used for evaluating the adhesivity of asphalts on a semi-practical scale, the idea being that it might be possible to work out some correlation between the small laboratory adhesivity tests and the large scale circular track tests. This circular track test was described by August Holmes, Chemist, Standard Oil Development Co., Elizabeth, N. J., in a paper, "Evaluating the Adhesive Properties of Asphalt," presented at the recent 42nd annual meeting of the American Society for Testing Materials.

The circular track employed consists of a concrete trough 2 ft. wide and 16 ft. in mean diameter in which hot-mixed paving mixture is placed and then compacted by the machine. The machine consists of a centrally pivoted, mechanically rotated beam supporting at its end two truck wheels equipped with heavy duty tires which have been loaded to give a dead weight of 1,000 lb. on each tire. The linear speed of the wheels is 4.54 m.p.h. and they make seven passages from one side of the trough to the other each hour, to eliminate rutting. After suitable compaction followed by a curing period, the asphalt-aggregate mixture is broken down by running the wheels over the track submerged under water maintained at 90 ±1 F. The breakdown of the track is taken as the number of revolutions of the machine required to loosen 300 lb. (10 per cent) of the total asphalt-aggregate mixture laid.

This track is being used to measure from an adhesivity standpoint the relative life of paving mixtures using asphalts which have been submitted to various theatments. In order to obtain accelerated results, asphalts having a softening point of 85 F. have been generally used, although it is realized that this consistency is much lower than the asphalts normally used in road construction. The aggregate used in these tests was trap rock from a local quarry made up to the following grading:

	Per Cent
Passing 1-in. sieve retained on ¾-in. sieve.	9.0 to 10.0
Passing ¾-in. sieve, retained on ½-in. sieve.	13.5 to 14.5
Passing ½-in. sieve, retained on No. 4 sieve	28.0 to 29.0
Passing No. 4 sieve, retained on No. 10 sieve	20.0 to 21.0
Passing No. 10 sieve, retained on No. 100 sieve	23.0 to 24.5
Passing No. 100 sieve	3.5 to 5.0

In carrying out the circular track tests, differences were early noted in the properties of stone shipments received from the same quarry at various times. Washing the aggregate was found to be necessary to reduce the deviation in track evaluation.

In an investigation carried out to determine the means to reduce the variation in circular track results, it has been found that:

(*a*) Increasing the compaction period from 2 hours running to 10 hours increased the apparent life of the paving mixture around 30 per cent but with a decrease in the reproductiblity of the results.

(*b*) Increasing the load on the wheel from 1,000 lb. to 1,500 lb. during the compaction period increased the deviation in the final results.

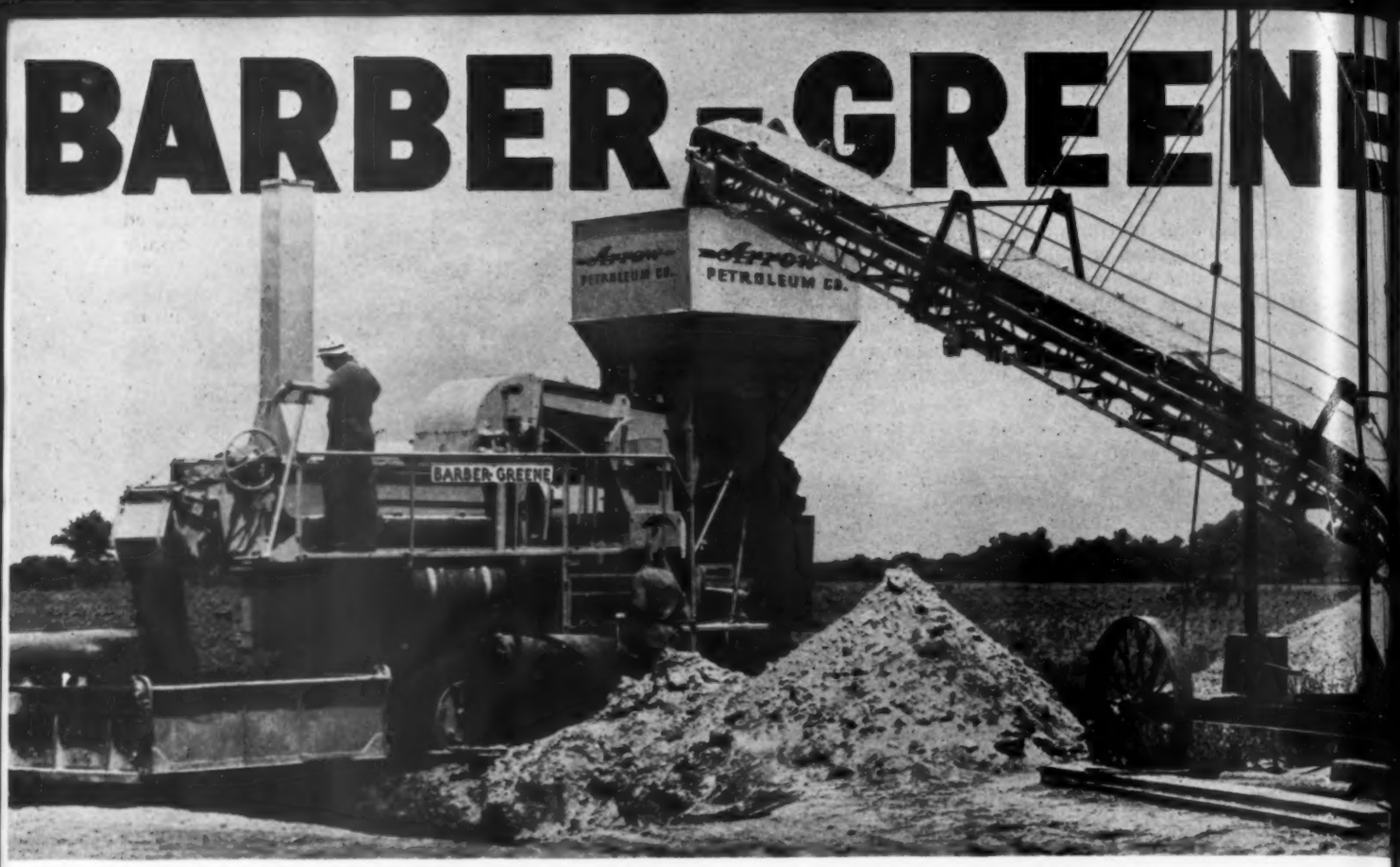
(*c*) Increasing the curing period prior to test from 16 to 64 hours had little effect on the apparent life of the track.

(*d*) Varying the temperature of the test between 78 F and 90 F. showed a mean increase of 840 revolutions for each degree decrease of temperature at which the track test is made.

(*e*) Varying the consistency of the asphalt binder with the test carried out at 90 F. gave an indicated increase of track life of around 450 revolutions for each degree rise in softening point.

Comparison with information from other sources has indicated that uniformity of results is promoted by carrying out the circular track test continuously; that is, to operate 24 hours a day until the track finally fails. The effect of extended shut-downs during the test is to increase the apparent life of the track, due possibly to a healing effect of the asphalt during the period of rest.

BARBER-GREENE



THIS is a typical low cost, high capacity Barber-Greene Bituminous Drying, Mixing, and Finishing Plant. You'll be interested in the essential facts listed below:

Contractor—Arrow Petroleum Company, Chicago, Ill.

Job — Paving road north of Barrington, Illinois. 3½ miles long, 20 feet wide, 2⅝" thick.

Actual Plant Production—125 Tons Per Hour.

EQUIPMENT AND LABOR

Machines	Operators	Laborers
1—¾ Yard Clam Shell	1	0
1—Barber-Greene Reciprocating Feeder 1—Barber-Greene Bucket Elevator 1—Barber-Greene Dual Drum Dryer 1—Boiler 1—Barber-Greene 60′ Portable Conveyor 1—Barber-Greene Mixer	2	2
1—Barber-Greene Tamping Leveling Finisher..	2	1
1—Roller	1	0
TOTALS	6	3

The above tabulation does not include trucks or drivers for delivering materials to the plant, or for hauling the mix from the plant to the Finisher. This equipment varies, depending upon the length of haul.

Type of Mix — Illinois C-6 Specification using dense graded aggregate from 1" to 200 mesh, adding 4.42% RT-7 Tar at 170° F.

Drying—Removing 5% moisture from aggregate at 125 tons per hour.

Cooling—Aggregate cooled to 180° F. by B-G Conveyor prior to mixing.

MOBILITY—The B-G units are built to be moved from one job to another with the least time and expense. This has been most successfully accomplished by having all of the units complete, independent assemblies that may be moved easily with practically no knocking down. Setting up the plant like the one above is chiefly a matter of arranging the units. Pneumatic tires on the Dryer and Mixer greatly facilitate the moving operation.

VERSATILITY—The owner of this B-G Equipment is not restricted to any type of mix or set-up.

He has the basic equipment for every type of bituminous and stabilizing job.

For the high type mixes, bituminous concrete, etc., he can add B-G screen and bin control equipment for separately handling and separately proportioning the different sizes of graded aggregates.

PERFORMANCE *Facts*

In combination with a B-G Bucket Loader, he can operate as a Travel Plant on all types of bituminous work, including: Tars; RC, MC, and SC Cut-back Asphalts; Emulsions; as well as all types of stabilization, including: Clay, Salt, Emulsion, Tar, Asphalt, Cement.

B-G MIXER—Backed up by approvals and enviable records of 83 machines sold in the past few years, the Barber-Greene Mixer is thoroughly established as the outstanding machine for high capacity, high portability, low cost operation, and close control.

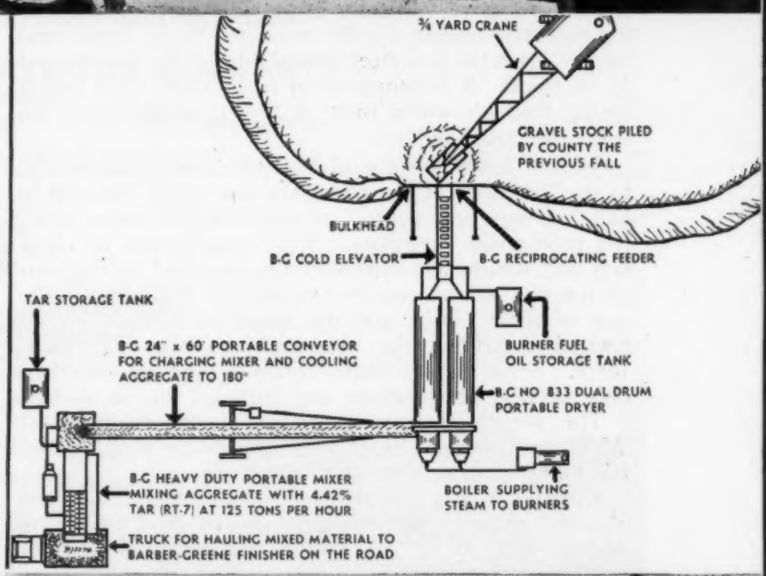
B-G FINISHER—The Barber-Greene Tamping Leveling Finisher has set new standards of excellence for bituminous paving. This machine, probably the most ingenious design in the road building industry, has been manufactured on a production schedule for the past two years.

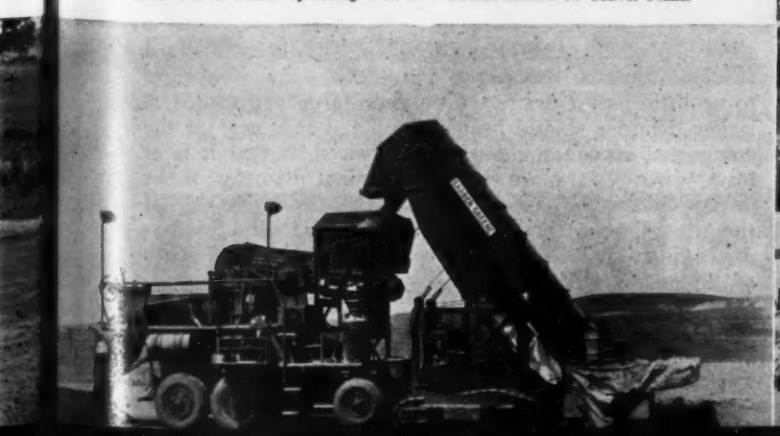
B-G DUAL DRUM DRYER—This, the newest Barber-Greene, completes the B-G line of bituminous equipment. Having undergone close observation in the field for over a year, this new unit is now released. Its combination of high capacity and high portability is accomplished by two parallel drums of comparatively shorter length and smaller diameter, splitting the volume to be dried, and getting a higher drying efficiency.

Literature on all of these Barber-Greenes will be sent on request. Phone, write, or wire. There is no obligation.

BARBER GREENE

AURORA, ILLINOIS 39-25

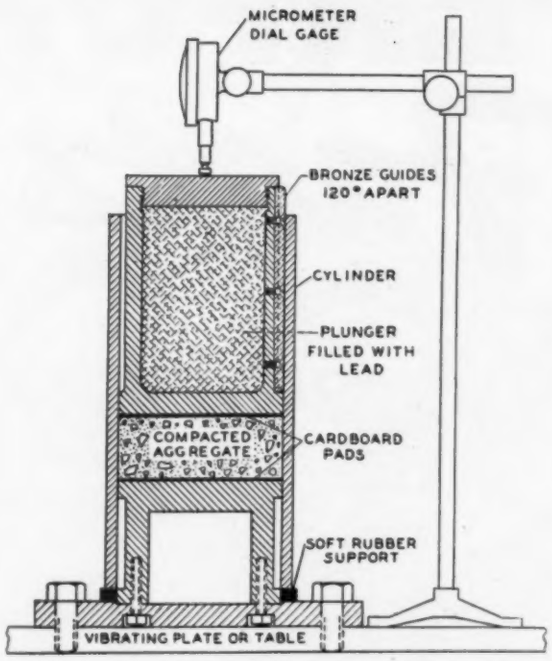

¾ YARD CRANE
GRAVEL STOCK PILED BY COUNTY THE PREVIOUS FALL
BULKHEAD
B-G COLD ELEVATOR
B-G RECIPROCATING FEEDER
TAR STORAGE TANK
B-G 24" x 60' PORTABLE CONVEYOR FOR CHARGING MIXER AND COOLING AGGREGATE TO 180°
BURNER FUEL OIL STORAGE TANK
B-G NO 833 DUAL DRUM PORTABLE DRYER
B-G HEAVY DUTY PORTABLE MIXER MIXING AGGREGATE WITH 4.42% TAR (RT-7) AT 125 TONS PER HOUR
BOILER SUPPLYING STEAM TO BURNERS
TRUCK FOR HAULING MIXED MATERIAL TO BARBER-GREENE FINISHER ON THE ROAD



Below: B-G Mixer operating with B-G Bucket Loader as Travel Plant.

NEW MACHINE FOR DETERMINING COMPACTIBILITY OF AGGREGATES

IN order to obtain consistently a high degree of consolidation during construction, it is essential to know in advance the limits of compactibility of the materials used. Such tests as have been employed to determine the attainable density of materials, among which are dry rodding, shaking, and various molding tests involving tamping and direct compression, do not always give consistent results. Furthermore, they fail to show the maximum compactibility limits of many aggregates. The U. S. Bureau of Public Roads has been using for some time a small vibrator called the voids determinator for the determination of voids in sheet asphalt aggregates. This vibrator, however, does not give consistent results for mixtures containing high percentages of dust; and, since the testing cylinder has a capacity of only 25 cubic centimeters, it is not suitable for testing aggregates containing large fragments. Accordingly, a new machine has been developed that produces more consistent results and higher densities, and which appears to be equally satisfactory for all gradations of aggregates commonly used in both base and surface construction. This new machine is described by J. T. Pauls, Senior Highway Engineer and J. F. Goode, Junior Highway Engineer of the Bureau in the May issue of Public Roads.



Cylinder and Plunger Assembly with Measuring Device

The machine consists essentially of a floating table that is made to move vertically in periodic motion by rotating eccentric masses rigidly connected to its lower surface. The table is a steel plate 13 by 24 in. in size and ¾ in. thick. It is supported at each corner by a helical spring through which there is a vertical guidepost on which the table slides.

On the lower surface of the table, mounted parallel to the long axis of the plate, are two shafts running in ball bearings and geared to rotate at the same speed but in opposite directions. Four steel blocks of equal size and weight are symmetrically mounted at the ends of the two shafts, one at each end of each shaft. The size of these blocks and the speed at which they are rotated determine the magnitude of the unbalanced force. Since the two shafts rotate in opposite directions only vertical accelerations are imparted to the system.

The weight shafts are rotated at speeds of 4,300, 2,500, or 1,500 revolutions per minute by a 3-h.p. electric motor with a 3-speed, V-belt drive.

By trial it was found that the best compaction was obtained with a total eccentric weight of 1,100 grams located 1 1/16 in. off center and rotating at 4,300 revolutions per minute. For these particular conditions the maximum centrifugal force developed by each of the four eccentric masses is theoretically about 338 lbs. In the extreme upper and lower positions these forces add to give a theoretical total vertical resultant of about 1,350 lbs. while at the midpoint between these positions the forces developed by the weights on one shaft exactly balance those of the other shaft and the total horizontal resultant is 0 lb.

At a frequency of 4,300 cycles per minute a powerful vibration is developed in the entire mass.

The assembly for holding the aggregate to be tested is bolted to the top of the vibrating plate or table. Its essential parts are a base plate and bottom plunger bolted to the table, a cylinder fitting over the bottom plunger and resting on a rubber support, and a top plunger which rests on the test material in the cylinder.

A micrometer dial mounted on a suitable base is used in conjunction with a series of calibrated gage blocks to measure the thickness of the compacted specimen without removing it from the cylinder.

The top plunger imposes a dead load of 1.75 lbs. per square inch on the sample to be compacted. This dead load generally provides sufficient confinement to flatten the top of the specimen and to prevent segregation of the particle sizes. Both the top and bottom plungers have just sufficient clearance within the cylinder to allow free vertical movement during vibration, and each is fitted with three bronze guide strips to maintain it in a position parallel to the axis of the cylinder. The loss of fine aggregate is held to a minimum by the insertion of close-fitting pasteboard gaskets or pads above and below the test specimen. A suitable correction is made in the measured height of the specimen to allow for the final thickness of the pads.

In making a test, the first step is to obtain an initial or zero reading with the micrometer dial on the combined height of the two plungers with the two pasteboard pads compressed between the plungers by vibration for a short period. For this zero reading a steel spacer gage of the approximate thickness of a compacted specimen is inserted under the dial so that its ¾ or 1-in. range of travel will not be exceeded when the specimen is in place.

For tests in the 4-in. cylinder, which is the one used for aggregates up to about 1-in. maximum size, sufficient aggregate is sused to produce a compacted specimen approximately 1½ to 1¾ in. high. This requires about 750 grams of aggregate.

If desired, a much smaller cylinder may be used when testing fine aggregates such as soil, sand, rock dust, or sheet asphalt aggregate, and the depth of the compacted specimen may be reduced to 1 in. or less and its weight to as little as 75 grams. For very large aggregates, a larger cylinder should be used and the thickness of the compacted specimen should be increased so that it is at least ½ to ¾ in. more than the nominal diameter of the largest individual aggregate particle. The weight of the top plunger should be such that the dead load is approximately 1 lb. per square inch per inch of depth of the compacted specimen.

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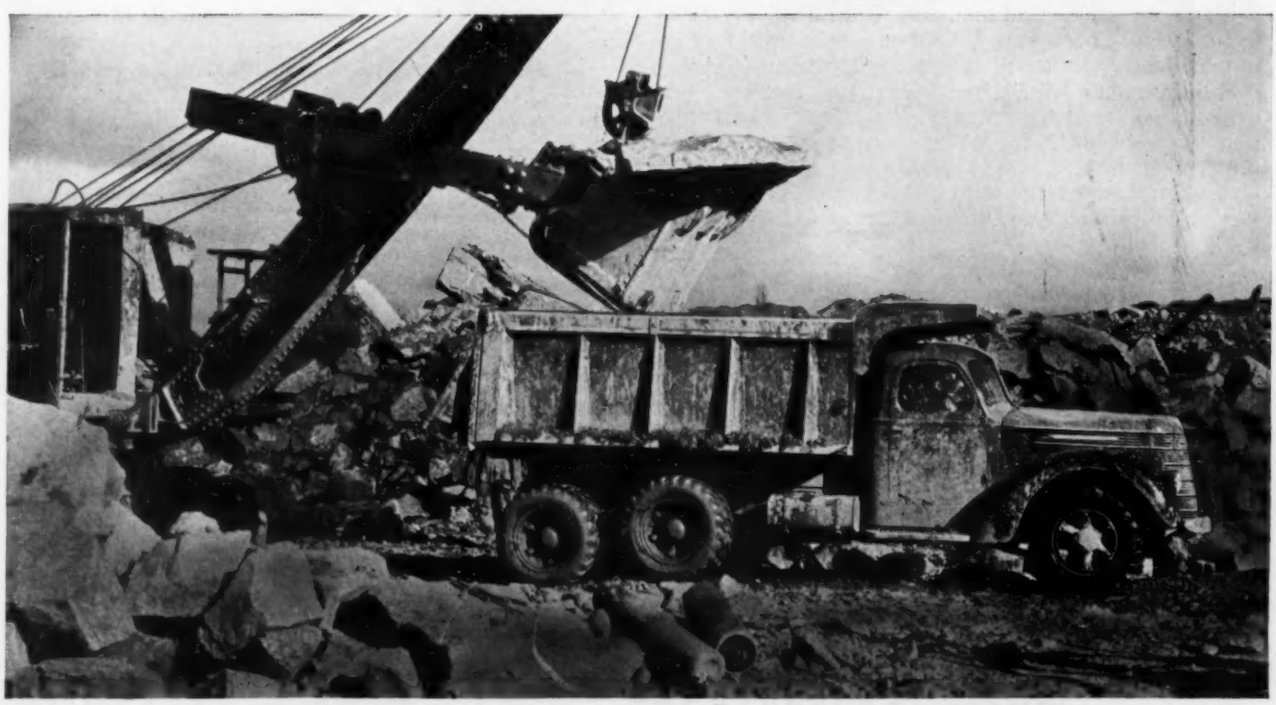

International Six-Wheel Trucks (dual-drive and trailing-axle) offer many advantages for dump truck work, such as: (1) greater payload in proportion to truck weight; (2) better load distribution; (3) substantial savings on tires, fuel, and lubrication; (4) longer life, with savings on maintenance; (5) greater safety, maneuverability, and ease of handling; (6) improved riding qualities.

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It is essential that the loose aggregate be placed in the cylinder without segregation. When the aggregate to be tested has a large percentage retained on the No. 10 sieve it has been found that the addition of about 50 to 70 cubic centimeters of kerosene to 750 grams of aggregate aids greatly in preventing segregation and does not interfere with compaction. The most satisfactory amount of kerosene seems to be that which will just fill the voids in the compacted aggregate.

Materials such as fine soil, sand, clay, etc., are not particularly subject to segregation and, because of the greater difficulty with which air is forced out of them when wet, do not always compact as well with kerosene as without. They are therefore tested dry.

▼

SOILS AT THE A.S.T.M. MEETING

CONSIDERABLE emphasis at the 42nd annual meeting, June 26 to 30, of the American Society for Testing Materials was on the subject of soils. One full session on Wednesday evening was devoted to this subject. It was featured by a Symposium on Shear Testing of Soils developed by A.S.T.M. Committee D-18's subgroup on testing for shearing resistance of soils, headed by Professor Converse, California Institute of Technology. There was a special display under the committee's auspices of various types of apparatus and equipment used in shear testing.

Tentative Standards Recommended for Adoption— In its annual report Committee D-18 recommended for reference to Society letter ballot the adoption as standard of seven existing tentative standards covering various tests, liquid limit, field moisture equivalent, shrinkage factors, etc. There were published in the report as information only, but with the thought that in the very near future they would be submitted as tentative, four methods covering the following: moisture-density relations of soil-cement mixtures; durability of compacted soil-cement mixtures by repeated freezing and thawing; durability of compacted soil-cement mixtures by repeated wetting and drying; and stabilization of soils with emulsified asphalt.

Shear Tests—Messrs. Hogentogler and Barber of the U. S. Bureau of Public Roads in their extensive paper on "Principles of Triaxial Shear Tests" indicated a number of advantages of the triaxial or compression stabilometer device, at the same time describing a simplified apparatus with interchangeable parts which provide for two general test methods, the so-called closed system and open system.

J. D. Watson, Harvard University, in describing a triaxial testing apparatus for determining stress-deformation characteristics of soils, on the basis of extensive work under way in the Harvard Laboratory since 1932, summarized certain criticisms of the direct shear test, including: (1) the boundary conditions produce irregular distribution of the normal and shearing stresses and leave the intermediate principal stress unknown; (2) in soils which show a rapid drop in shearing resistance after the maximum value is reached, no type of grating can produce sufficiently uniform distribution of the shearing stresses to prevent progressive failure; (3) it is practically impossible to determine in direct shear tests, with the accuracy usually required, either the strain or the volume changes during the test. At the same time he listed the advantages of triaxial tests as follows: (1) all principal stresses are known; (2) for practical purposes progressive failure is eliminated; (3) the strain and the volume changes of the test specimen can be accurately determined; (4) the size of the sample used has no apparent effect on either the intensity of volume change or the strength of the material.

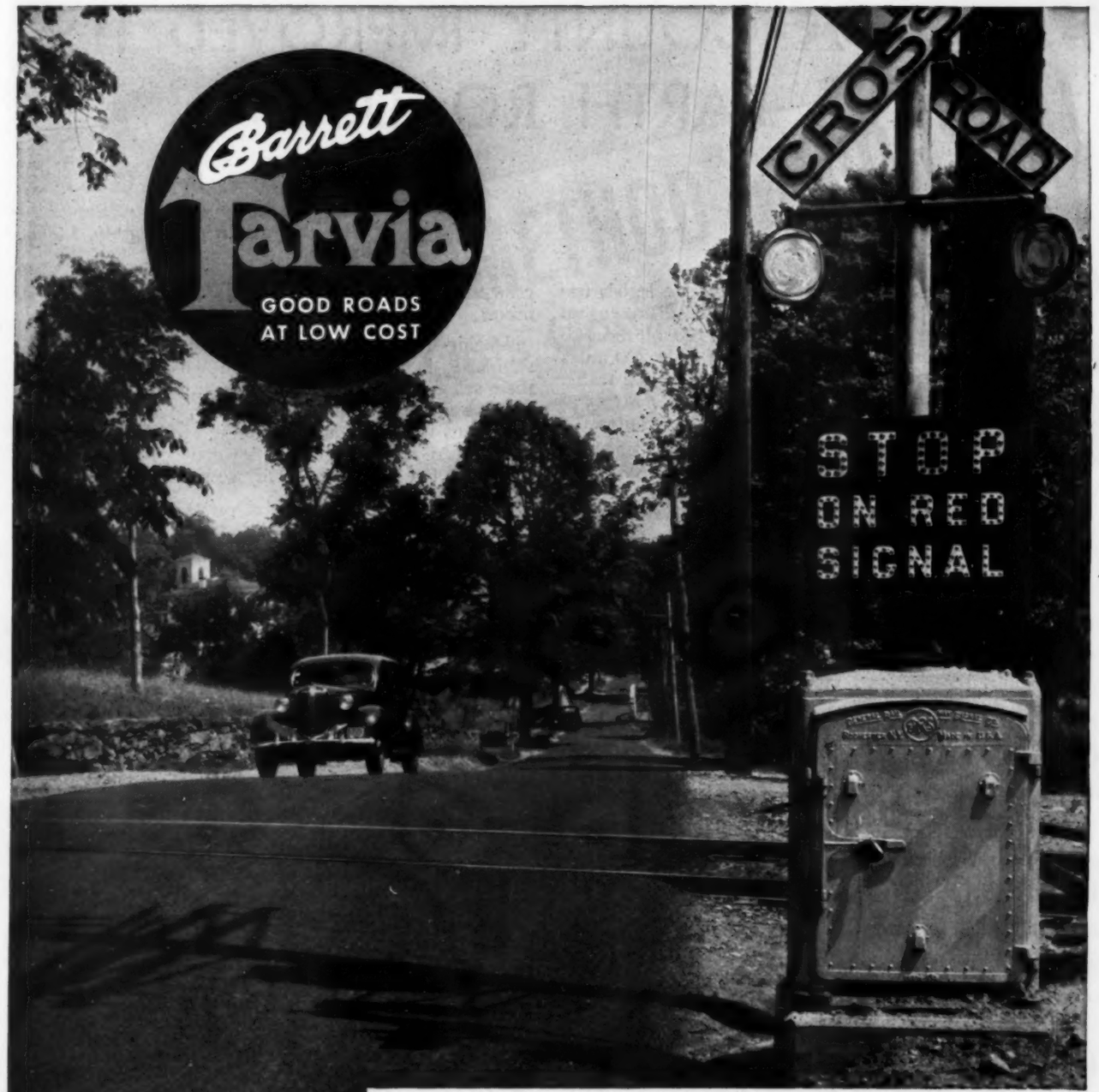
M. J. Hvorslev, Research Engineer for the Soil Mechanics and Foundation Division of the American Society of Civil Engineers, described various types of apparatus for torsional shear tests on soils which seemed to offer the best, and in the case of many clays, the only method of determining the start and velocity of the slow plastic flow before failure.

Prof. D. W. Taylor, Massachusetts Institute of Technology, compared the results of direct shear and cylindrical compression or triaxial compression results, concluding that the cylindrical compression machine is recognized as the more valuable for fundamental research. A limitation of this apparatus is that ultimate properties cannot be obtained satisfactorily on it. The direct shear apparatus is more rapid and simpler and it is believed that in testing work of a routine nature, especially after more comparisons are available to serve as a calibration, this apparatus will furnish the majority of the shearing properties of sand with satisfactory accuracy.

Prof. G. P. Tschebotareff, Princeton University, in his paper on "Some Practical Aspects of Soil Shear Testing," indicated that he felt one should discriminate between (1) shear tests performed for the purpose of numerically estimating the actual shearing resistance of different types of undisturbed soils under varying field conditions and (2) shear tests performed for the purpose of selection of the most suitable soil by means of comparison of the shearing properties of different disturbed soils to be used as an engineering material in the field under identical conditions or recompaction. He stated that for the first type of test the standardization of the testing procedure would appear to be not only harmful, but to be entirely impossible, at least for the present time. The great variety of possible field conditions under which an undisturbed soil may be subjected to shearing stresses and deformations, combined with the variety of factors affecting the shearing resistance of a soil, renders it most inadvisable to impose for such cases any definite manner of soil shear testing.

However, for cases where arises the practical question of selection of a most suitable soil to be used as an engineering material (for dams, embankments, etc.) a definite testing procedure could and should be worked out to provide a uniform basis of comparison.

Prof. W. S. Housel, University of Michigan, in covering measurement and practical significance of shearing resistance of cohesive soil, concluded that true cohesion in accordance with the generally accepted definition and the treatment of cohesive soil as a continuous medium rather than two phases acting independently, permits simplification of methods of measurement and the practical application of shearing resistance. To accept this viewpoint necessarily eliminates apparent cohesion and the surface tension device as a mechanism to describe cohesion. This choice must be made by the individual as there appears to be no compromise between the two conceptions. Any attempt to retain them both will only prolong the period of uncertainty and confusion.



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HOW A COUNTY IMPROVED ITS EARTH ROADS

By J. C. ECKERT
County Surveyor and Road Supervisor
Ripley County, Indiana

WHEN the special session of the state legislature in 1932 passed the law turning all township roads over to the county, only 100 of the 500 miles of these roads were improved. At least 200 miles of the 400 miles of earth roads carried as much traffic as many of the stone surfaced county roads. Many of these earth roads were mail and school bus routes.

In as much as these roads were now classified as county roads, and the county accordingly received a larger share of gasoline tax, people believed that the county would have more money available for roads than it needed, and it would be an easy matter to get these earth roads improved at once. As a result, at every commissioner's meeting we were swamped with delegations requesting improvement of their particular road.

As a result of all these requests, it was necessary to decide on some definite program for the selection of the roads to be improved and then to stick to it. In the first place, we decided that we would put no surfacing material on a road until it was properly graded and drained. Much material had been wasted in this way in previous years.

Selecting the Roads for Improvement

The following points in the order named were considered in selecting the roads to be improved:

(1) Roads which were both school bus and mail routes,
(2) Roads which were either school bus or mail routes,
(3) Roads which would get the most homes out of the mud in proportion to their length,
(4) Roads which would shorten the distance between two important local points.

In addition to the above, local conditions such as a rural school, church, or cemetery were given consideration.

In our effort to get every home at least one year round outlet, we have surfaced only a part of the road in several cases. For instance, on a mile of earth road connecting two stone surfaced roads, there might be houses ¼ mile from each end. Where this road was not a mail or school bus route, we usually graded the entire road, but surfaced only the portion that had to be used.

Grading Operations

Our next problem was equipment. In addition to what we had on hand, we purchased enough extra equipment to give us two grading units, each consisting of one 50 h.p. crawler type tractor, one 10 ft. blade grader, and one 2 yd. scraper. These units work separately, one in the north half and one in the south half of the county. In addition, we employed a former contractor with a similar unit for a part of each grading season. For bridge and culvert work we organized a bridge crew, and equipped it with a truck and 1-bag concrete mixer.

During 1933 and 1934 we did not use any certain standards in grading. Several townships consolidated their schools and the demand for grading was so heavy that we felt under the circumstances, volume was more important than a wide grade. On level land where the fences were far enough apart, we tried to get a 20 ft. road bed, but in cuts and hilly sections this varied considerably.

In 1935 we started staking out our roads, improving alignment and grade, and getting a full 20 ft. roadbed, with 26 ft. between ditch lines. Our standards now, as set up by the state highway department under the 1937 Acts for a 1-lane road, are as follows:

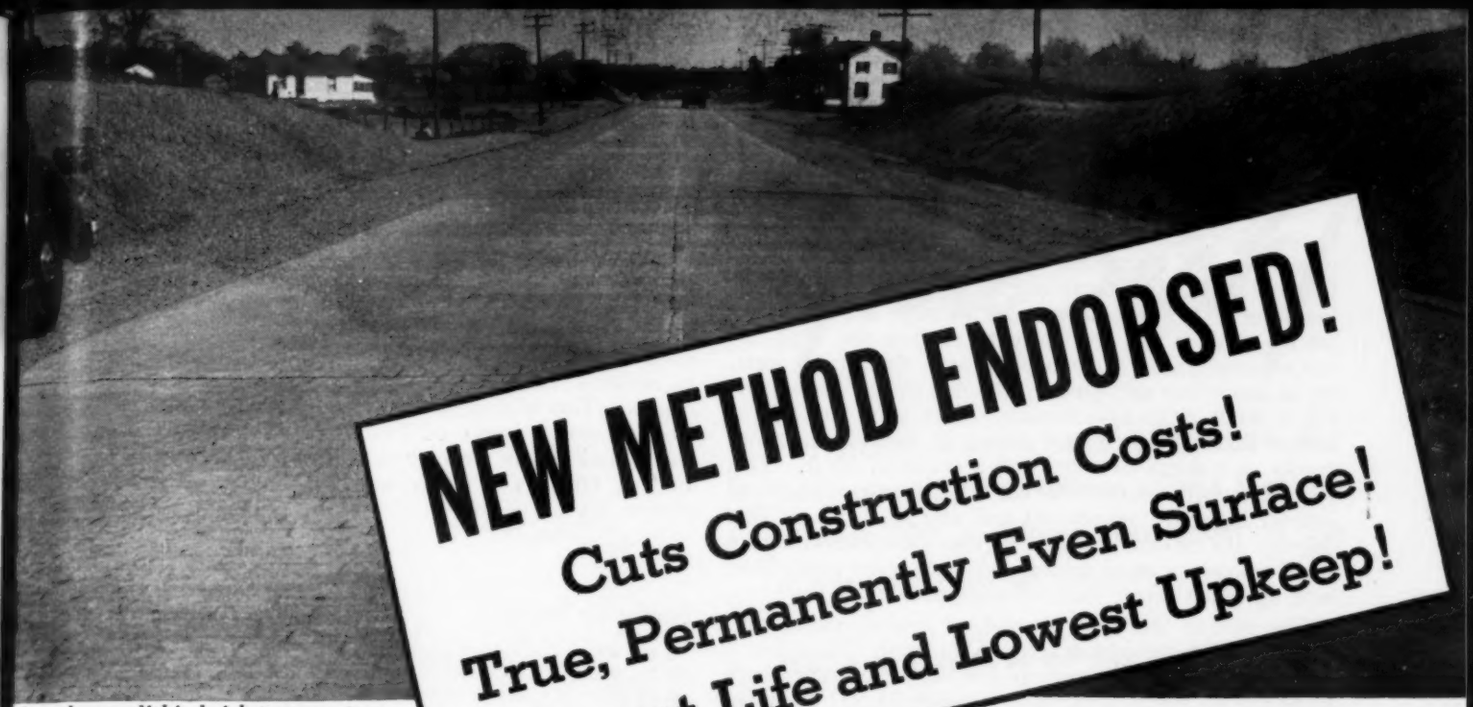
(1) 40 ft. minimum right-of-way
(2) 22 ft. roadbed
(3) 2 to 1 slope from berm line to ditch
(4) 1½ to 1 back slope.

During 1938 we constructed 2½ miles under these specifications, after approval by the state highway department.

Drainage Structure

After a road was selected to be improved, we first went over the road with the assistant supervisor for the particular township in which it was located, checking up on the necessary culverts and bridges, and setting right-of-way and ditch line stakes. Grade stakes were set only where major changes occurred. The sizes and types of drainage structures being decided upon, the bridge crew was sent on the job to do the work necessary before the grading started. As soon as possible, the grader unit started work with the assistant supervisor in charge. Our ditches average 18 in. deep, usually V-type, and we leave from 4 to 6 in. of crown in the roadbed.

For drainage structures we use corrugated metal pipe in all cases where 24 in. or smaller will take care of the drainage area. In cases where footing conditions are bad, we sometimes use pipes of larger diameter. However, we have found that we can build a small culvert cheaper than a pipe when we have to go over a 2 ft. diameter. Except in special cases, pipes of sufficient length to eliminate head-walls are used. We have in our county an abundance of good building stone, and in more cases we can get a stone foundation for footings. In construction of small culverts and bridges, we build our abutments heavy enough to take care of a reinforced concrete floor; but except on a few of the heavier traveled roads, we usually use a native timber floor, consisting of black locust stringers and white oak flooring. A floor of this type can be built at little cost, will last several years and can be replaced at some future time with reinforced concrete.



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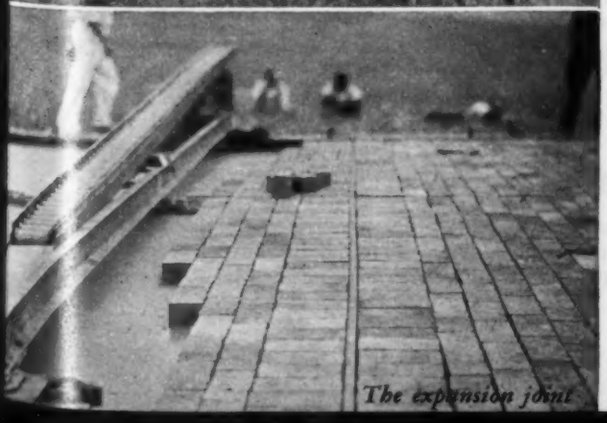

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Surfacing with Crushed Stone

As soon as the grade is completed and opened to traffic, it is maintained with motor graders. By fall it is usually well compacted by traffic and in good shape for surfacing. For surfacing material, we use crushed limestone, No. 7 size, all passing through a 1 in. square screen. When we are ready to surface the road, we use a motor grader to remove most of the crown, starting at the center and pushing the dirt to each side, leaving a small ridge approximately 5 ft. each side of the center line. The crushed stone is then spread with trucks to a depth of 4 in., and a width of 10 ft. This requires approximately 660 cu. yd. per mile. The road is then regularly maintained and any weak places that develop are repaired. With regular maintenance and a small amount of stone added each year, these roads have held up much better than we anticipated.

The cost of this type of road, of course, varies considerably with the topography of the land. However, I can safely say that our average cost on these roads where there are no major structures is about $1,500 per mile, divided as follows: grading and draining $600, and surfacing material $900. This cost is arrived at by figuring our crushed stone at an average of $1.40 per cubic yard on the road. However, many of the roads cost us much less due to our W.P.A. stone crushing project whereby we get much of our stone delivered on the road at an average cost of 63 ct. per cubic yard. The roads which we graded last year according to the standards set up by the state, cost nearer $1,800 per mile.

With but few exceptions, we have used all the W.P.A. men we have available at crushing stone in privately owned quarries. When we advertise for crushed stone at the first of each year, we receive bids on two conditions. First, regular crushing, and second where we furnish the labor to the contractor. As a rule we let contracts to six or seven quarries scattered throughout the county. While our regular price averages 98 ct. per cubic yard in the bin, the price under the W.P.A. contract averages 63 ct. per cubic yard. In addition, by not requesting materials on our project, we have several trucks each month, paid by W.P.A., with which we haul the stone on the road.

In the five years from 1933 to 1937 inclusive, under the program we graded 158 miles of earth roads, and surfaced 128 miles with crushed stone. In 1938 we graded only 9 miles, and surfaced 6 miles. This was caused by the loss of $30,000 in revenue resulting from the new method of gasoline tax distribution.

In 1933 we received in gasoline tax $97,000. This gradually increased until in 1937 it amounted to $128,000. In 1938 under the new distribution law, this dropped to $98,000, and for 1939 we will receive approximately $84,000.

Although there are still some 50 to 75 miles of earth roads in Ripley County which should be improved, with this reduction in revenue and the gradual increase in maintenance, it looks as if our grading program must be completely stopped until some method of financing it can be devised.

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WHITESTONE BRIDGE EARNS $4,232 A DAY.—Since the opening to traffic of the Bronx-Whitestone bridge of the Triborough Bridge Authority, New York City, on April 29 through June 30 it carried 1,054,295 vehicles of all classifications, an average of 16,735 a day. These included 39,791 trucks, or an average of 632 a day. Its toll receipts were $266,643, or an average of $4,232 a day.

MAINTENANCE COSTS OF CALIFORNIA LIGHT TRAFFIC ROAD

There is a minimum maintenance necessary to preserve the original investment and keep the road in a satisfactory condition for any appreciable volume of traffic. This minimum is affected by location, type of construction, soil characteristics and the volume and class of traffic. Beyond this minimum, costs may cover as wide a range as the special services the public demands. This is illustrated by the following table, taken from a recent report of California Division of Highways, showing the average annual maintenance costs for varying volumes of traffic under 600 vehicles per day, over a 4-year period.

Vehicles Per Day by Groups	Miles Included	Average Annual Cost Per Mile for Traveled Way Only	Average Annual Cost Per Mile Total
0 to 49	354	$205	$256
50 to 99	672	230	397
100 to 149	862	272	478
150 to 199	649	281	505
200 to 249	515	285	523
250 to 299	672	277	511
300 to 349	416	321	621
350 to 399	319	268	518
400 to 449	471	306	612
450 to 499	485	322	636
500 to 549	327	307	617
550 to 599	250	348	676
Total	5,992	$281	$518

The traveled way cost, as referred to in the above table, covers work on the road surface which carries the traffic. The total cost includes the traveled way cost and such special services as traffic striping, maintenance of warning and directional signs, care of roadside plantings, snow removal, weed eradication, care of shoulders, and roadside drainage.

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Colorado Law Based on False Idea That Roads are "Built for Profit"

For the first time in annals of state legislation, the theory that highways are "built for profit," calling for inclusion "highway costs" of interest and taxes on public money spent for highway construction and on value of land used as right-of-way, has been formally approved by action of a legislature.

The Colorado legislature has adopted a resolution directing that 4 per cent interest on money spent for those purposes must be computed as part of the annual highway cost in studies to be made by the State Highway Department. The measure also stipulates that a tax of 1¼ per cent of the "investment" and a "use charge" of 4 per cent of the value of the land occupied by roads and streets shall also be included in the computation.

The resolution requires that the State Highway Department in preparing such report shall allocate 90 per cent of the total annual cost of primary roads, 60 per cent of local roads and 50 per cent of city streets to the motor vehicle operators.

The bills sponsoring this "public utility concept" as applied to computation of highway costs are the invention of railroad economists and propagandists. Its sole object is to increase the burden of taxation on highway users by computing levies on the basis of actual costs plus the fictitious charges of interest on the investment, and taxes on the public highways themselves as taxable property.

Railroad attorneys in other western states are reported as having actively advanced similar measures.—*National Highway Users Conference.*

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From Our Readers

"Are Highways Public Utilities"

To the Editor:

Your editorial entitled "Are Highways Public Utilities" which appeared in your excellent magazine under date June, 1939, moves me to reply primarily to the unfair statement that the Association of American Railroads employed Messrs. Breed, Older and Downs to make a case against highway transport. These engineers were retained by the railroads to make an impartial study of highway transport in the hope that something constructive might be contributed toward the formation of a sound national transport policy. They are not employed to make a case for the railroads any more than the writer of your editorial may be said to have been employed to make a case for the trucks. The fact that engineers may differ in their conception of a problem and in the analysis of facts is no reason for impugning false motives which in your case cannot but weaken the good effect of your editorial. Many of your readers doubtlessly will desire to see the other side to some of the questions you have raised.

There is nothing mysterious or complex in the public utility concept as it applies to the highways. A public utility is simply an enterprise of a public nature which instead of looking to general taxes for support depends upon the users of the service to pay the costs. No one will contend that it is not the general public policy to require highway users to pay an ever increasing proportion of the highway costs; and that such payments shall be in proportion to the facilities required and the services rendered. Also it is generally understood that motor vehicle imposts are not for the support of general government, but that they belong to the highways according to the public utility concept. Moreover, the U. S. District Court in the light of all the facts has decided that the highways and streets in the state do constitute a public utility. This public policy is dictated by public opinion which can no more be denied or thwarted by a cry of "fallacious argument" than could King Canute stop the tides in the sea.

Moreover, why should any one with unselfish interest in our highway problems oppose the public utility idea? Motor vehicle ownership and operation are so widely distributed that vehicle licenses and taxes reach into the pockets of all citizens directly or indirectly. The general public in any event pays the costs and it is a simple, easy and equitable way to collect the costs directly from the highway user.

When highway authorities understand that motor vehicle users and not the nebulous tax-paying public are supporting the highways will they not be more alert to motor vehicle needs and will not highway finance be on a sounder basis? As a matter of fact the general public has long since ceased to vote highway bonds, and general taxes for highway purposes are decreasing in most of the states. Except for Federal appropriations, including unemployment relief, highway finance in many states would be in a distressed condition. Much reconstruction work is necessary because of obsolescence and deterioration of highways that have served their useful life, but for which no provision was made for amortization. Many highways can be further improved with profit to motor vehicle users. Why not accept the public utility principles which are necessary to make our highways more efficient? Why not put the highway industry on a sound financial and economic basis?

Your editorial emphasizes the profit motive in the public utility concept. A public utility is not necessarily a profit-making enterprise. True, a privately-owned public utility is supposed to earn a reasonable profit in return for the financial risks; but this is in fact only a regulated rate of interest on the capital investment. A publicly-owned public utility such as the many public-owned water, gas and electric plants rarely earns a profit. It must, however, earn interest on the unamortized capital investment and must amortize its capital within the period of its useful service life whether that capital is represented by bonds or is a public contribution. "Money is always worthy of its hire." A striking inconsistency in your editorial is that you deny the interest charge on public funds derived from taxes, yet you admit that the interest charge must be considered in figuring the economy of the investment. An amortization charge is necessary to perpetuate the investment in any self-liquidating project and must be collected while the facilities are useful. You also admit that the amortization charge must be considered in figuring the economy of the investment.

The question of charging taxes on unamortized public capital is not so clear; yet so long as the nation's private wealth is subject to tax levies for the support of general government, that source of income can be conserved only when public capital used to compete in industry with private capital is also subject to the same tax levies. The present tax problem in Tennessee, where national and state authorities are seeking a way to save for the state the taxes on property which was acquired by the T.V.A. illustrates the point.

Rural public highways are not built for the purpose of benefiting private property any more than are railroads or water, gas, electric and telephone lines. The fundamental purpose of each of these utilities is to serve a form of transportation; yet all of these public utilities are of special benefit to the owners of private property and they serve to enhance taxable wealth. In the case of highways it was concluded in the Report to the Railroads that the cost of rights of way should not be charged to motor vehicles and furthermore a portion of the costs for highway and street improvements should be paid by general taxes. In the case of city streets 50 per cent of these costs was charged to general taxes.

Your editorial seeks to place highways in the same category as a city hall or court house which is solely an instrument of government and not an economic utility open to personal use. A public park or a publicly-owned swimming pool may or may not be a public utility depending upon whether it is, or is not, a self-liquidating enterprise. Many public swimming pools are operated as public utilities.

When a family installs a bath tub in the house it is as you say not a public utility. No more or less is an electric motor, a refrigerator or a privately-owned automobile a public utility. But if any of such privately-owned equipment requires a public utility service for its operation, such as water, gas or highways, the service itself must be paid for according to public utility principles.

In conclusion may it be said that the real question at issue in the report to the Railroads was not whether or not the highways are public utilities, but what is the true cost of highway transportation compared to other forms of transport. Based on the assumption that each form of transport possesses an economic field in which it is supreme, the public as well as the Railroads is

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interested to know these economic limitations as the basis for a national transport policy. Since the public must pay road and street costs as well as the costs of vehicle operation, it is necessary to determine true highway costs for all classes of motor vehicles in order to determine the complete highway transportation costs.

W. S. Downs,
Professor of Railway and Highway Engineering,
West Virginia University,
Morgantown, W. Va.

New Practical Test Procedure on Emulsified Asphalt for Soil Stabilization

To the Editor:

We appreciate Mr. C. L. McKesson's comments, published on Page 60 of the June issue of Roads and Streets relative to our article entitled "New Practical Test Procedure on Emulsified Asphalt for Soil Stabilization," published in the March, 1939, issue.

Any soil stabilization control test should be as rapid as possible, and should also use and measure forces which may be logically expected to occur in field construction. The method described by the writer is actually a punching shear test as pointed out by Mr. McKesson. The shape of the specimen tested appears desirable, because it provides a maximum opportunity for rapid water absorption and the shear test itself is not interfered with by large particles, since the material tested all passes a ¼ in. sieve. Larger particles are not of interest in this type of test.

Mr. McKesson points out that the 24-hour water absorption test used in our work is insufficient to affect the strength of stabilized specimens and that the water absorption should continue for a period of seven days. In the case of soil specimens which do not contain sufficient bitumen for proper stabilization, water absorption increases rapidly during the first 24 hours and more slowly, but appreciably, over a period up to at least 14 days, as shown in Fig 8 of the writer's article in the March issue of Roads and Streets. In all stabilized specimens there is a larger amount of water absorbed and more loss in strength in the first 24 hours than in a period of several additional days in the water absorption box. Consequently, we cannot see the justification of a longer period than necessary to obtain substantial differentiation, and the matter resolves itself to one of establishing proper limits on water absorption and strength after a 24-hour test. A suggested limit of 1 per cent absorption is found in the conclusion of the original article.

It has been found that the type specimen used by the authors (1 in. thick and 4 in. in diameter) frequently absorbs as high a percentage of water in 24 hours as does a sample 4 in. high and 2 in. in diameter in seven days.

We would like to correct any tendency to misinterpret the data shown in our article published in the March, 1939, issue of Roads and Streets. The data in Table I simply show that there is no correlation between the amount of 200-mesh material or plasticity index and stabilization results when using a constant asphalt percentage. This was stated in the article with no implication that Soil No. 1, having a plasticity index of 17.5, would be most satisfactory for stabilization. We do not believe that any readers familiar with emulsion stabilization would conclude that a typical clay such as Soil No. 1, having over 70 per cent material passing a 200-mesh sieve, would respond favorably to stabilization with 4.0 per cent asphalt.

While we believe that our procedure as presented is capable of quickly evaluating soils and emulsified asphalts for stabilization purposes, it is not claimed to be perfect and possess all the desirable characteristics. Our work was presented because it affords a simple and much quicker method of evaluation than that commonly used at the present time. This is considered essential in this type of work.

R. R. Thurston,
The Texas Company.

BOOK REVIEWS

Caminos Estabilizados, *by Juan Ignacio Planas, Civil Engineer, Louisiana State University and The University of Havana.* 113 pp. 6⅛ in. by 9¼ in., paper binding. Published by Compania Editora de Librosy Folletos, O'Reilly Numero 304, Havana, Cuba.

Stabilized roads have a definite place in those areas where traffic is not heavy enough to justify more expensive construction. This book discusses the theory and construction practices of soil stabilization for road building, giving formulae for calculating quantities of admixture required. The sequence of development of the subject is well arranged. The basis of the subject matter is principally from published matter in society proceedings and technical publications. The work is well done and should prove to be a valuable contribution on the subject of Road Stabilization for those who are able to read Spanish. The book is well illustrated and indicates that the author has an excellent knowledge of the subject.

Examinations for Engineers—The U. S. Civil Service Commission, Washington, D. C., will hold competitive examinations for the following positions: Senior Engineer, $4,600 a year; Engineer, $3,000; Associate Engineer, $3,200; Assistant Engineer, $2,600. In the broad field of Civil Engineering, lists will be established for the specialized fields of (a) Irrigation and Drainage, (b) Hydraulics, (c) Building Construction, and (d) Soil Mechanics. Separate lists will *not* be established in such branches as Highways, Structures, Construction (except Buildings), Railways, Municipal, Sanitary, Civil (General), etc., and applications based on experience in these lines will not be accepted. Applications must be on file with the Commission at Washington, D. C., not later than Aug. 14.

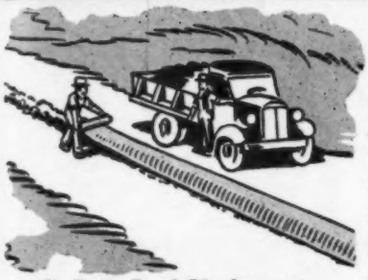
"Stop" Does Not Always Mean Stop

Surveys made recently by safety engineers of the Illinois Division of Highways showed that only one-third of the state's motorists habitually obey stop signs by coming to a complete stop, with the result that this type of violation heads the accident list in the destruction of human life.

Ten per cent of thousands of motorists observed entered intersections at speeds greater than 15 miles an hour; 14 per cent at speeds between three and 15 miles, and 41 per cent shifted to second gear and crept onto the intersection at a three-miles-an-hour or slower pace.

Analysis of the stop signs violations with reference to their cause revealed that in 87 per cent of the cases the guilty drivers deliberately failed to stop, eight per cent had been drinking, and the remainder stopped but failed to grant the right-of-way to approaching vehicles.

When Rain Comes - DOES YOUR PROFIT GO!



YOUR profit on the job can be eaten up by labor costs drying out windrows, lost time, wasted materials, idle equipment and demurrage — unless you protect your aggregate against profit-destroying rain.

Cover your windrows — both ahead and behind your mixer—with tough, waterproof Sisalkraft Road Blankets. Low in original cost, Sisalkraft is so tough it can be used over and over again — pays for itself repeatedly in time and labor saved — and speeding up of the job.

Sisalkraft Road Blankets are available in convenient sizes — specially pre-treated for high wet-strength—to resist shrinkage, scuffing, and fungus rot due to soil bacteria.

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Stop THE WEATHER
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Stop YOU!

Protect aggregate, stock piles, machinery and equipment with tough, waterproof Sisalkraft—quickly available everywhere. Write for complete information and test sample of Sisalkraft—see how tough and strong it is.

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ANY excavating or conveying job that requires moving materials a few hundred feet or more can be handled economically by a Sauerman machine. The Sauerman line includes:

Drag Scrapers and Slackline Scrapers ranging in size from ¼ cu. yd. to 15 cu. yd.

Slackline Cableways up to 3¼ cu. yd. in size for wide and deep excavations either in dry ground or under water.

Portable Scraper Loaders.

Tower Excavators for building levees, strip mining and similar work requiring a mobile machine with a long reach.

Tautline Cableways for lifting, conveying and placing materials.

Whenever you have a long-range material-handling problem of any kind, it will pay you to find out how much you can save by doing your work the Sauerman way.

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Above is a Sauerman Tautline Cableway handling concrete, steel and forms on a bridge job. View at right shows a Sauerman Scraper supplying two asphalt mixing plants with sand from hill. Operating cost of scraper is $8 per day.

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MALL TOOL COMPANY
7765 South Chicago Avenue Chicago, Illinois

EDITORIAL

OUR TASK

NEITHER the oil industry nor the automobile association contend that the gasoline tax is illogical or inequitable as a means of financing road and street improvement work. Since these two organized groups are about the most articulate of all tax paying groups their position on this question should be fairly well understood by the public in general. Diversions of these funds for other uses than highway improvement is recognized quite generally as a violation of the trust the road user placed in the legislator he helped to elect, when that legislator votes to divert revenues that have been specifically levied for road and street improvement. Yet, as John Hix would say, "Strange as it seems," diversions in New York State alone have reached an all-time high, approximating $73,000,000.

A ray of hope, however, may be seen on the horizon. While the gross amount diverted by all states may equal or even exceed that of previous years, there is developing an awareness of the injustice imposed by diverting these funds. The public generally, and legislators in particular, are coming to recognize the propriety of dedicating highway tax revenues to the purposes for which they are levied. Five more states took legislative steps toward constitutional dedication of highway funds to highway purposes. Idaho, Iowa, South Dakota and Wisconsin took initial legislative action, and Nevada took the necessary second and final legislative action to place such amendments before the electorate. The Iowa and Wisconsin resolutions must again be passed by succeeding legislatures. In addition to the four states having constitutional provisions prohibiting diversion (Kansas, Colorado, Missouri and Minnesota), the States of California, Michigan and New Hampshire adopted anti-diversion amendments at the last general election. By approving a special highway bond issue last November, the people of Montana effectively raised a barrier against diversion for the next ten years. While North Dakota reenacted its present anti-diversion statute, an initiative measure was presented for election on July 11 to divert most of their funds to old age pensions. The measure was defeated by a 7 to 1 vote. Actual diversions were defeated in many states. Outstanding among these are Florida, Tennessee and Washington.

The reason why these funds have been grabbed by politicians is an old story. In fairness to many of our legislators we should say that too often they have been forced against their better judgment, because of diminished normal sources of revenue, because of changing and unfavorable economic conditions, and because of impaired appreciation of fundamentals, to support measures with which they hold little sympathy. It is the task of the highway industry to keep the injustice of diversion before our legislators continually until the last diverted dollar has been stopped.

PUBLIC UTILITY VS. PUBLIC CONVENIENCE

IN a letter published elsewhere in this issue, the question was asked, "Moreover, why should anyone with unselfish interest in our highway problems oppose the public utility idea?"

As the writer understands the public utility concept as applied in our commercial or economic order, a certain sum of money is *invested* for the purpose of realizing a rate of return on the investment. Funds employed in public utility enterprises are expected to earn a profit. Being monopolistic in nature, those businesses could exact (and the writer believes some do) an income, hence profit, in excess of a return comparable to what might exist if they had competition. The underlying principle is that the enterprise is commercial and the money invested therein must earn a profit. While the writer has a selfish interest in our highway problems, nevertheless, it is not difficult for him to compare the characteristics of a public convenience with those of a public utility and to recognize that a profit motive is not expected to apply to highway construction and maintenance expenditures.

Furthermore, there are additional factors that should help pay the cost of streets and highways other than highway users. The community in general benefits and should help pay street and highway costs; individual property owners benefit and should help pay costs; but these costs do not mean outlay plus a percentage for profit.

A public utility pays taxes, and should, because it is part of the private business property in the community, whereas street and highway structures are not part of private business properties and therefore pay no taxes. In this characteristic they are at variance with public utilities, also. For these reasons the writer opposes the idea of classifying streets and highways as public utilities. They are public conveniences.

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CORRECTION

In the July issue on page 64 we published a picture of members and directors of the American Road Builders' Association who visited the General Motors exhibit at the New York World's Fair, entitled "Highways and Horizons."

We omitted the name of Mr. Chauncey B. Smythe, Vice President, Thew Shovel Company. Mr. Smythe is standing in the back row immediately back of and between Mr. Parrish and Mr. Pennybacker of the front row. He is an active road builder and we apologize for the omission of his name. Please write it on the caption to that picture.

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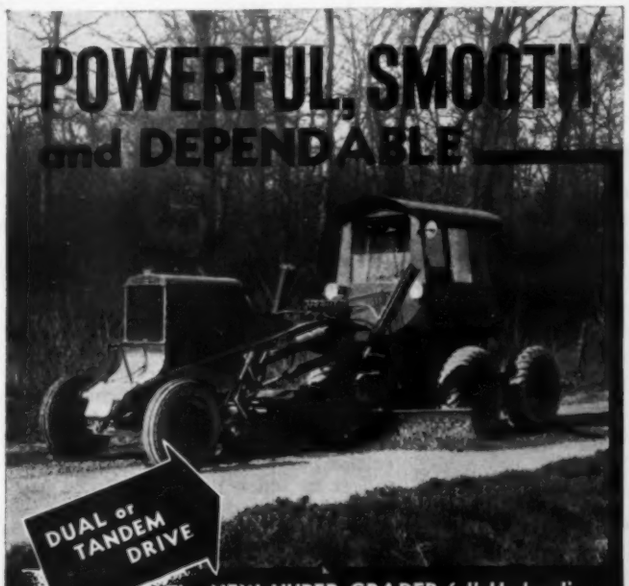

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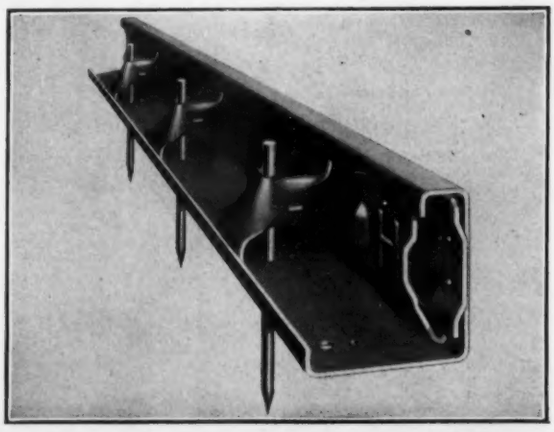

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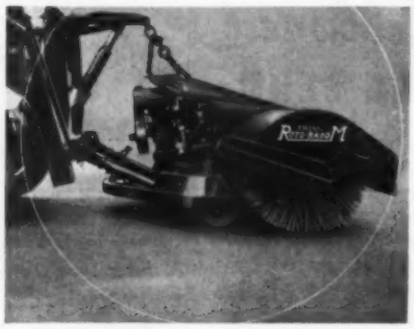
HELTZEL STEEL FORM & IRON CO.
WARREN, OHIO U.S.A.

NEW EQUIPMENT AND MATERIALS

New Roto-Broom

A new power rotary sweeper has been developed and is being marketed under the trade name "Roto-Broom" by Carl H. Frink, Clayton, N. Y., the manufacturer of the well known line of Frink Sno-Plows for motor trucks and tractors. The Roto-Broom attaches to the front end of any motor truck. The broom assembly is readily reversible for sweeping either to the right or to the left as the operator may desire or may be locked in the central position to sweep straight ahead. A flexible hook-up to the motor truck permits oscillation of the broom assembly, to closely follow any unevenness in the street or other surface being swept. The height of the brush is controlled by a convenient adjustment between the broom assembly and the chassis assembly. This adjustment also compensates for wear of the brush filler. Generous sized castor wheels with double tube pneumatic tires carry the weight of the Roto-Broom and facilitate guiding it in any direction without attention from the truck operator. The Roto-Broom is powered by a 4 HP., air coled Wisconsin gasoline engine, coupled to the broom through enclosed worm and gear speed reducer, sprockets and roller chain. The speed of the rotating brush is approximately 102 r.p.m. and it cleans a space about 7 ft. wide. The brush core is refillable. Self-aligning ball bearings are used on the brush and all drive shafts. Provision is made for directing a sheet of finely atomized water down in the front of the brush when being operated under extremely dusty conditions. Water pressure is provided by a V-belt driven in centrifugal type pump which draws water through a flexible hose from a barrel or other suitable receptacle in the dump body of the truck. When not in use, the broom is raised for carrying by means of the regular Frink Sno-Plow truck attachment mounted on the front end of the truck. Those who already have the truck attachment with their Sno-Plow may obtain the Roto-Broom less this attachment and thereby effect a saving.



New Frink Roto-Broom

New Diesel Electric Sets

Two new, completely self-contained diesel electric sets of 15 and 20 kilowatt capacity, designed to bring low cost lighting and power to construction jobs, have been announced by the Caterpillar Tractor Co., Peoria, Ill. All electrical equipment required by the sets is inbuilt, with the exception of the circuit breaker. No rheostats, switchboards, instruments or compli-

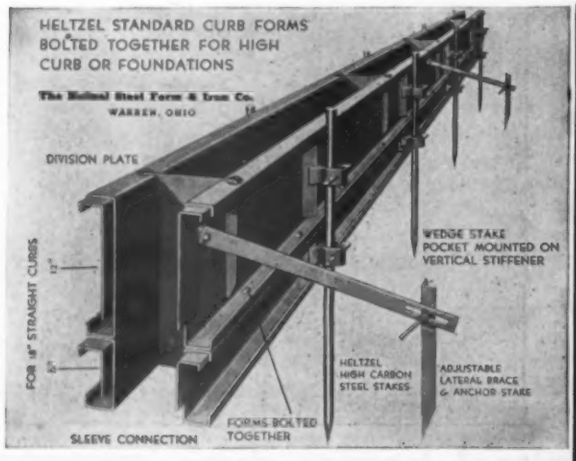
New "Caterpillar" Diesel Electric Set

cations of any sort are needed. The engines have but three operating adjustments, none of which involves the diesel fuel system. The generators are of single unit construction, equipped with ball bearings, which require lubrication only once in six months. Built-in regulation enables the sets to pick up relatively large motor loads with little light flicker and voltage drop. The two sizes available, as announced, are the 34-15 and the 44-20. The former set is supplied in 3-phase, 110, 220 or 440 volts at 15 KW., .8 power factor. It is also available as single phase, 110/220 volts, three wire type, and 110 and 220 volt two wire type at 13 KW., .8 power factor. The 44-20 set is supplied in 3-phase, 110, 220 or 440 volts, at 20 KW., .8 power factor. It is also available as single phase, 110/220 volts, three wire type; and 110 and 220 volts, two wire type at 18.5 KW., .8 power factor.

▼

New Shiftoguide for Truck Operation

A new Shiftoguide speedometer has been introduced by the Ford Motor Co. as standard equipment on all Ford regular and cab-over-engine trucks, except ¾-ton and 1-ton types. The new instrument does away with guess work in gear shifting and is stated to do virtually everything that a tachometer would do for the truck operator. The dial of the Shiftoguide speedometer shows at a glance the correct speed ranges in which the truck should be operated in low, second, third and high gears. As the speedometer pointer crosses the line dividing the different ranges, the operator knows that is the correct time to shift the gears up or down as load and road conditions demand. He doesn't have to rely on experience, instinct or "feel" to get best results from his truck. The Shiftoguide speedometer is calibrated to show that gears should be shifted as follows when accelerating: Low to second at 6 miles per hour; second to third at 12 miles per hour; and third to high at 26 miles per hour. When pulling loads up long grades, the proper speeds for shifting to lower gears are the same as those above but in the reverse sequence.



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TOOL BOXES
FINISHING TOOLS FOR CONCRETE ROADS

HELTZEL STEEL FORM & IRON CO.
WARREN, OHIO, U.S.A.

New ¾-Ton Truck

A new ¾ ton truck has been brought out by the Ford Motor Co., bringing to 49 the number of body and chassis types included in the Ford V-8 truck and commercial car line. The new truck has a 122-in. wheelbase chasis and is available with panel, express, stake and platform bodies and as chassis with cab, chassis with cowl and chassis with windshield. Bodies are large and roomy and particularly adapted to bulky loads. The panel body has a load length of 107¼ in., load width of 55½ in., and height of 55¼ in. The express body has a load length of 96 in., load width of 54 in., with sides 22¼ in. high. The stake body has a load length of 90 in., load width of 74 in. The stakes are 39 in. high. The platform measures 93 in. in length, 77 in. in width. Hydraulic brakes are 12 in. in diameter and 1¾ in. wide, front and rear, giving a total drum area of 264 in. and brake lining area of 162 in. The rear axle is full-floating. For maximum economy the 60 H.P. engine is available with 6.67 to 1 rear axle gear ratio. When brilliant performance is the chief aim, the 85 H.P. engine and 4.11 or 4.86 to 1 rear axle ratio are recommended. A 3-speed transmission is standard and a 4-speed transmission available at extra cost. Wheels have full drop center rims 16 in. by 5 in. and carry 6:50-16 six ply tires in front and 7:00-16 six ply tires on rear wheels.

New ¾ Ton Ford Truck

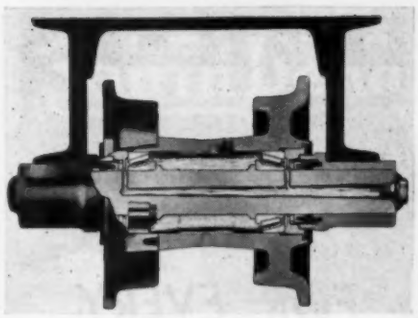
New Vibrator

A new combination vibrator rig has been announced by the Concrete Equipment Manufacturers, 80 East Jackson Boulevard, Chicago, Ill. The rig is mounted on a square swivel base with handles and wheel attachments that are removable, and installed in five minutes. The Marvel-Wyco vibrators are powered by Wisconsin air-cooled gasoline engines through a flexible shaft traveling in the Marvel patented housing or casing, which is almost indestructible. Models in all sizes, powered by both gasoline engines as well as electric motors, are available.

New Marvel—Wyco Vibrator

New Truck Wheel Assembly for Tractors

A new, positive-seal truck wheel assembly for tractors which is claimed to eliminate daily roller greasing has been announced by Allis-Chalmers Manufacturing Co., Milwaukee, Wis. In this new truck wheel assembly, ordinary bearings are replaced by tapered roller bearings with a positive-seal arrangement that keeps in lubricating oil and keeps out dirt, dust, mud and grit. Lubrication, according to Allis-Chalmers engineers, is required only once every 200 operating hours instead of every 8 hours as heretofore. It is stated further that not only does this new positive-seal arrangement keep out dirt and other foreign materials, but it is so constructed that all of the old oil is forced out each time the assembly is lubricated. Thus the user is doubly protected against abrasive grit working into his track assembly. At present this new truck wheel is available on Allis-Chalmers tractor models "M," "K," "K-O," "S" and "S-O."



New Truck Wheel Assembly

Cut Yardage Costs to the Bone
The ⅜ and ½ Yard Insley Type K Excavators are the answer to the problem of lower yardage costs. Ample power for faster digging and swinging. Sturdily built and easy to handle in close quarters, they are ideal equipment where time and space demand maximum efficiency. Ask for Bulletin No. 137 for complete specifications. Insley Manufacturing Corporation, 801 Olney Street, Indianapolis, Indiana.

● *Available in 1/2 and 3/8 cubic yard capacities. Electrically welded for maximum strength. Ball bearings eliminate friction and wear. Electric bucket trip facilitates accurate placement.*

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MARION OHIO

New Haulage Unit Convertible from Track to Wheel Operation

The Linn Manufacturing Corporation, Morris, N. Y., has announced a new haulage unit, known as the Model C-5, which

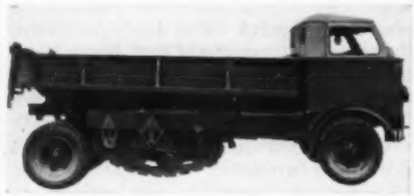

Fig. 1—The Linn C-5 on Dual Pneumatic Tired Wheels. For Track Operation, the Driver Merely Pushes the Control and the Rear Wheels Are Raised Hydraulically.

can be instantly converted from track to wheel operation, or vice versa, merely by throwing a control lever mounted at the driver's position. Figure 1 shows the C-5 operating on dual pneumatic tired wheels, with 7 in. of road clearance under the traction unit. In this position the drive is on the front wheels; the traction unit idling and merely revolving should it hit an obstruction. The load distribution is 50/50 on front and rear wheels, with a maximum speed of 35 M.P.H. When track operation is desired, the operator merely pushes the control lever and the rear wheels are raised hydraulically. The wheels can be raised to allow 9 in. of road clearance, or they can be allowed to trail or float behind the traction unit. The unit is of the proved, flexible Linn design. When the C-5 is operating on tracks, the load distribution is 75 per cent on the tracks and 25 per cent on the front wheels, with the drive on the tracks and front wheels simultaneously. Maximum speeds, loaded, on tracks is 12 M.P.H. The hydraulic jackknife lever unit which raises and lowers the rear wheels is shown in Fig. 2. This unit locks off center so that when operating on wheels the load is carried on the rear axle only,

Fig. 2—Hydraulic Jackknife Lever Unit Which Raises and Lowers the Rear Wheels. Unit Locks Off Center, the Load Being Carried on the Rear Axle, Never on Cylinder.

never on the cylinder. The body capacity of the C-5 is 5 tons, and the chassis weight, with cab, approximately 11,500 lb. The engine is a 6-cylinder Hercules, built to special Linn specifications, rated at 165 B.H.P. at 2400 R.P.M. Gasoline or Diesel power is optional. The engine is mounted on a track, underneath the air-conditioned cab, and can be readily removed from the front end. The track parts, while having far greater strength, have been greatly reduced in weight to appreciably cut track maintenance. All shafts are tubular and are used for oil or lubricant reservoirs to minimize lubrication needs. The track suspension spring arrangement is designed so that the entire assembly is placed inside the frame outrigger, just over the tracks themselves. Standard equipment includes: four wheel hydraulic brakes, parking brake, electric lights and starter, tail and stop light, shock absorbers, windshield wiper, two tow eyes in front and rear drawhead, complete tool kit, etc.

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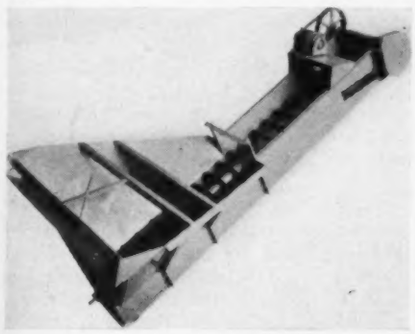
Here Is Relief for Thirsty Road Gang

A portable drinking fountain for supplying clean, cool drinking water to the men on the construction job has been brought out by the Dobbins Manufacturing Co., North St. Paul, Minn. It is stated that water placed in this insulated fountain at 50 deg. F. will rise less than 10 degrees in 10 hours even if it is subjected to a constant outside temperature of 90 degrees. The inside container holding the water is made of heavy gauge Enduro Stainless steel, product of Republic Steel Corporation, Cleveland, O. Between this and an outside jacket of galvanized steel are several layers of corrugated air cell insulating material. A 5½ inch filler opening permits use of ice if desired. The flow is supplied through a tilting type of bubbler operated by a slight thumb pressure. An Enduro stainless steel guard around the bubbler affords sanitary protections for the user. A built-in-valve keeps the water flow constant at all times. Four gallons is a standard capacity Dobbins fountain. This size weighs 22 lbs., is 8⅜ ins. in diameter and has an overall height of 27 ins.

Dobbins Portable Drinking Fountain

New Sand Classifier

Recognizing the steadily increasing demand for closely graded sands, the Smith Engineering Works, Milwaukee, Wis., has recently developed a new sand classifier. It dewaters, rewashes, and classifies sand, operating on the same principle as the well-known Telsmith sand drag. In order to secure closer gradation of fine and coarse sands, the water capacity is greatly increased and a larger screw is furnished, greater in length and with a spiral of shorter pitch set at a considerably steeper angle. According to its designers, the new sand classifier not only produces a well-watered product, but is capable of handling larger water capacities. Water overflow velocity and size of finished product are regulated by a new type of quickly adjusted control. The screw, of special abrasion-resisting steel, is mounted on a shaft, having a water-lubricated, cutless rubber bearing at the lower end, and combined thrust and radial Timken bearing at the upper end. All moving parts are substantially mounted in a steel box of special shape. The new Telsmith sand classifier is made in single and double screw types with sand capacities from 10 to 60 cu. yds. hourly. Illustration shows the 20 in. x 15 ft. single screw, with a capacity of 25-30 cu. yd. per hour of coarse sand.



New Telsmith Sand Classifier

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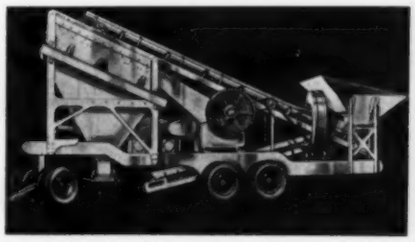
New Dual Crushing Plant

A new model dual crushing plant has been introduced by the Universal Crusher Co., Cedar Rapids, Ia. In this new model the belt conveyor return system for feeding back material from both the primary jaw crusher and the secondary crushing rolls has been replaced by a new turbine type revolving elevator called the rotavator, which conveys material discharged into it by the under crusher return conveyor to the screen feed conveyor directly above the latter. The savings in weight and overall length and width that result from the use of the rotavator are claimed to provide a far lighter, more portable unit and to actually shorten the cycle, speeding up production. The Rotavator is made under the Morrissey patents and patents pending which have been assigned to the Universal Crusher Co. and merged with their patent claims. Features of the Morrissey wheel have also been incorporated in the design of the Rotavator. Other equipment of the new Universal duplex includes: a 2½ deck 3 ft. x 8 ft. screen, hopper and grizzly feeder, sand ejector, streamlined 10 in. x 36 in. lightweight crusher and 30 in. x 18 in. rolls. The plant is of welded construction, has 12 low pressure tires to meet state road regulations, and requires only one operator.



New Duplex Crushing Plant

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New Mix-in-Place Machine

A new machine for mixed-in-place road construction has been announced by Ariens Co., Brillion, Wis. The machine is known as the "Aggmixer" and is a development from their small power operated ground tillers. The illustration shows the machine in operation and the machine itself. It has a welded steel frame of one-piece construction, and equipped with low pressure tractor tires. It has a removable draw bar easily adjusted to fit various tractors, removable seat, if tractor controls are used, and a power take-off shaft to fit any tractor take-off. Equipped with a hydraulic pump, hydraulic valve and reservoir, it also has a depth adjustment to meet conditions. The tines are easily replaced, the only tool being required is a hammer. The spring and clamp assemblies also are easily removable from the hexagonal shaft. The tail piece is adjustable for work on road shoulders, etc. The breaker board, made of wood, can be folded up. It has a simple, sturdy drive, entirely enclosed. The machine is Timken and ball bearings throughout. When not in use a ram lock is provided to hold the machine.

The "Aggmixer"

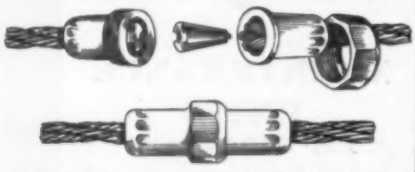
South Bend
31 YEARS EXPERIENCE
BITUMINOUS MATERIAL DISTRIBUTORS
●
MAINTENANCE UNITS
For Bituminous Surfaces
●
Street Sprinklers
●
Street Flushers
●
Gutter Snipe
Pickup Sweepers
●
Traffic Line Markers
●
MUNICIPAL SUPPLY COMPANY
SOUTH BEND, IND.

WITH THE MANUFACTURERS

Construction Machinery & Supply Co. Appointed Distributor for Rex Line

The Chain Belt Co., Milwaukee, Wis., has appointed the Construction Machinery & Supply Co., 617 State St., Toledo, O., as its distributor of Rex construction machinery in the Toledo area. W. L. Gibson, president of the firm, is well known in the machinery industry and has had a great deal of experience in the construction field. The Construction Machinery & Supply Co. handles the complete line of Rex construction machinery and carries in stock late models of Rex mixers and pumps.

Guard Cable Splice of Approved Design



This Wedge Type Union Cable Splice for standard 3-strand, 7-wire ¾" guard cable is the simplest, most easily installed and most economical cable splice we know about that will meet specifications requiring safety factor over cable of 25,000 lbs. rating.

Now used regularly in seven States and acceptable in others. Should be standard with any State now using the ¾" guard cable construction—both for maintenance and for new construction.

Sample will be sent free for field test by responsible Highway Official or Contractor; or trial order of any quantity at 66c each, F.O.B. Branford. Lower prices in quantity and through distributors.

Send for Data Sheet No. H-1

Other M.I.F. Specialties include: Cable Offset Fittings, Compensating Spring Anchorages, Wedge Type Cable End Sets, Offset Pipe Railings, etc.

MIF

MALLEABLE IRON FITTINGS CO.
Pole Hardware Dept.
Branford, Conn.

Good Roads to Manufacture and Sell Speed Dumper

Good Roads Machinery Corporation, Kennett Square, Pa., has been granted exclusive rights for the manufacture and sale of the Speed Dumper, truck hoist and multiple bucket equipment for loading, hauling and dumping earth, rock, etc. Speed Dump, Inc., New York City, was the original maker.

▼

Link-Belt Speeder Corporation Organized

Announcement has been made by Alfred Kauffmann, president, Link-Belt Co., Chicago, that the company has organized the Link-Belt Speeder Corporation, a wholly-owned subsidiary but operated independently, with headquarters at 301 W. Pershing Road, Chicago, for the manufacture and sale of power-operated excavating and materials handling shovels, draglines, cranes, including a full line of track-type locomotive cranes. This news follows closely on the heels of Mr. Kauffmann's announcement a few months ago of the consolidation of Speeder Machinery Corporation, Cedar Rapids, and the Shovel Division of Link-Belt Co., Chicago, which now become the Link-Belt Speeder Corporation. The products of the new corporation will be manufactured both at Cedar Rapids and Chicago, and marketed through a large list of authorized distributors. The organizing committee named the following directors to serve for the first year: Alfred Kauffmann, T. M. Deal, Walter Baker, W. C. Carter, H. E. Kellogg. The directors have elected the following officers: Alfred Kauffmann, chairman of board; T. M. Deal, president; Walter Baker, vice-president; W. C. Carter, vice-president; H. E. Kellogg, treasurer; G. H. Olson, secretary; O. A. Prather, assistant secretary; H. E. Kellogg, assistant secretary, and F. V. MacArthur, assistant treasurer.

T. M. Deal

Banishes the Road Widening Problem

THE TROJAN ROAD WIDENER

Originally built in 1933, developed and improved since then on actual work, the TROJAN has proven without a doubt that for RAPID, ACCURATE, ECONOMICAL Road Widening Excavation—

IT HAS NO EQUAL

CONTRACTORS MACHINERY CORP. Batavia, New York

NEW LITERATURE

Manganese Steel Castings.—The American Manganese Steel Division, Chicago Heights, Ill., has issued a new 64 page catalog with over 400 illustrations showing manganese steel castings for every industry using equipment, the parts of which are exposed to impact and abrasion. An introductory section asks the question, "What is Manganese Steel?"; then proceeds to answer it, covering origin and physical properties. Information follows on plant and research facilities and method of manufacture, concluding with many pages illustrating uses.

Scrapers, Bulldozers, Etc.—Two new folders illustrating and describing its equipment have been issued by R. G. Le Tourneau, Inc., Peoria, Ill. The General Construction 12 page folder deals with the entire Le Tourneau line—'dozers, carryalls, sheep's foot rollers, rooters, tractor cranes and power control units. Pictures of different types of jobs and varied job conditions are included. The County and Government folder pictures Le Tourneau 'dozers, carryalls, and rooters on highway maintenance and construction jobs.

Traffic Control Devices.—Equipment and accessories for traffic control are pictured and explained by the Magnetic Signal Company, 3355 East Slauson Ave., Los Angeles, Calif., in their new Bulletin T-11, entitled "Traffic Control Devices for Street and Highway Safety." Flashing signs, reflectorized signs, colored or clear beacons and flasher control boxes are described. An insert shows a new protected flashing signal post.

Willamette-Hyster Publication—A striking publication released by Willamette-Hyster Co., Portland, Oregon, entitled "Lifts" is gotten up in the style of "Life" magazine and looks a great deal like the latter. It shows by illustration the many uses to which the company products may be put, not only in the highway field, but also in general construction. The hoist is attachable to Caterpillar tractors. Land clearing tackle and gravel pit equipment are pictured and line drawings show how they are used. In bridge building the units find varied employment. Special tractor donkeys and towing winches are pictured.

"Instruments for Testing Cement, Soils, and Petroleum and Its Products"—Is the title of a new 164-page catalog just published by the American Instrument Co., Silver Spring, Md. The Cement Section includes instruments for testing portland cement, concrete, mortar, aggregates, lime, gypsum, etc. The Soils Section deals with the testing of the mechanical stability of soils and includes the latest developments in instruments used by civil engineers, and subgrade and road materials testing laboratories. The Petroleum Section is devoted to the testing of crude and refined petroleum, greases, compounds, gasoline, naphtha, kerosene, bitumen, asphalt, pitch, tar, paraffin wax, creosote, etc. Those who make application on their business stationery will receive this book without charge.

ANOKA GETS A NEW KIND OF TRAFFIC COP!

● See how this concrete island, made with Atlas White, dominates the whole road at Anoka, Minn. General contractor, McCree & Co., St. Paul. Sub-Contractor, Crown Sidewalk & Blk., Co., Minneapolis. Engineers, Minn. Dept. of Highways.

WHITE CONCRETE ISLANDS—on duty day and night, for years to come—need no upkeep!

ANOKA, Minn., has adopted a more efficient way to cut down accidents. Traffic is now kept safely apart by a permanent traffic cop —WHITE concrete islands!

This highly visible strip of white concrete is raised above the road surface. Motorists can see it day or night, in all kinds of weather. And, made with Atlas White portland cement, its whiteness is *permanent*. So it will dominate the road for years and years to come—without repainting, replacing, or other upkeep.

Think what this can mean to a city's budget —what it will mean to yours . . . when you put this road-divider to work, cutting down your accidents and your maintenance expenses!

White islands made with Atlas White, like the one above, can be placed on the job or pre-cast. Universal Atlas Cement Co. (United States Steel Corporation Subsidiary) Chrysler Bldg., N. Y.

RS-M-7

ATLAS **WHITE** PORTLAND CEMENT FOR MARKERS AND CURBS

ROADS and STREETS

With which have been merged GOOD ROADS and ENGINEERING & CONTRACTING

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CONTENTS

STABILIZED BASE CONSTRUCTION ON MISSISSIPPI'S ROUTE 15 23
By A. B. COVELL
Gen'l Sup't, R. B. Tyler Co., Louisville, Ky.

LOW COST CONSTRUCTION IN FLORIDA 30
By DON JONES
International Harvester Co.

COLORADO MOUNTAIN PASSES OPEN YEAR 'ROUND 31

STATE AID ROAD BUILDING IN MAINE BY DAY LABOR 33
By L. D. BARROWS
Chief Engineer, Maine State Highway Commission

OBSERVATIONS BY THE WAY 38
By A. PUDDLE JUMPER

AMERICAN ROAD BUILDERS' REVIEW 40

SOILS SELECTED FOR UNCONTROLLED FILL COMPACTION 42

RESURFACING WITH NATURAL ROCK ASPHALT 53
By N. F. SCHAFER
Engineer of Maintenance, State Highway Commission of Indiana

A WELL-CONDUCTED CONCRETE JOB IN ILLINOIS 60

TIMBER CONSTRUCTION IN THE PUGET ISLAND-CATHLAMET BRIDGE 66

EDITORIAL 72

NEW EQUIPMENT AND MATERIALS 74

WITH THE MANUFACTURERS 78

NEW LITERATURE 81